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Emergency Medical Technician Performance Evaluation

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CIRCULATE

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May 1978

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Abstract

An evaluation was conducted of the diagnostic accuracy and treatment appropriateness of emergency medical technicians (EMTs) in caring for 4,455 consecutive patients during a four and one-half month period. Data on EMT diagnosis and treatment and physician diagnosis were collected, and EMT data validated by observers. There were 58 diagnostic conditions for which treatments were mandated as determined by a physician panel, affecting 2,233 (50 percent) patients. EMT diagnostic accuracy was measured using physician diagnosis as the standard, and rates of appropriate treatment were based upon the list of mandated treatments. Diagnostic accuracy tended to be mediocre, but treatment appropriateness varied by diagnosis and severity. Serious medical and trauma conditions received appropriate treatment far more frequently than non-serious conditions. Essential changes in educational approach and emphasis are discussed.

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This issue presents the full report on "Emergency Medical Technician Performance Evaluation," excluding Appendix C and D, in order to expedite the dissemination of this information. The full final report, including measures of EMT performance in each diagnostic group, data collection forms and personnel training manuals, is available for sale to the public by the National Technical Information Service, Springfield, VA 22161 (tel.: 703/557-4650), order number PB 272 379.

Copies of this abbreviated report are available on request to NCHSR, Office of Scientific and Technical Information, 3700 East-West Highway, Hyattsville, MD 20782 (tel.: 301/436-8970).

Other NCHSR reports of related interest are "Emergency Medical Services: Research Methodology" (PHS) 78-3195, and "Emergency Medical Services Systems Research Projects, 1977" (HRA) 77-3194.

Foreword

In the operation of a system for delivering emergency medical care, the greatest single expense to a community is probably the training and employment of Emergency Medical Technicians (EMTs). It is the EMT's responsibility to provide initial care at the scene and stabilize care during transport to an appropriate facility for definitive care. The effectiveness of an emergency medical services system depends to a great extent on the performance of these prehospital activities. An important advance in improving prehospital emergency care was the Department of Transportation's development of a standard training program for EMTs, but even successful completion of an accepted course cannot guarantee adequate performance in the field. This report offers a method for measuring the extent to which EMTs actually carry out the diagnostic and treatment tasks for which they were trained. The method was developed and applied in one community in the northeast. The results, which suggest the need for major changes in the training program, are provocative, although they are directly applicable only to the test community. By far the most important product of the study is the evaluative method itself. To the community needing more meaningful information about its prehospital care system than simply numbers of personnel trained or ambulance response time, this approach offers a straightforward, relatively simple, and relatively inexpensive way of examining that system's performance.

Gerald Rosenthal, Ph.D.
Director
May 1978

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Introduction

Each year there is a tremendous amount of injury or loss of human life through trauma and sudden medical illness.[1] This year more than 50,000 people will die from auto accidents; 12,000 will die from burns; and many thousands from drowning.[2] Cardiac disease is now the number one cause of sudden death in America.[3] Millions of people will be involved in some form of trauma or medical emergency. Many of these patients will receive little or no prehospital emergency medical care because of the lack of adequately trained personnel or proper equipment.[4]

Phase I, the period of time between the initial injury and the patient's arrival at a medical facility, is a critical period during which life saving measures may be instituted if adequately trained and equipped personnel are available. Approximately 17% of those trauma victims who die at the scene or en route to the hospital do so from conditions which may be reversible by simple measures delivered by appropriately trained paramedical personnel.[5] The patient who experiences a sudden medical emergency and subsequently has a cardiac arrest has no chance of survival without help; however, with optimal paramedical care between 12% and 18% may survive and "walk out" of the hospital.[6] Providing victims of accidental injury and sudden medical emergencies with the optimal prospect of survival and lowest level of disability requires a large number of well trained and equipped emergency rescue paramedics; an efficient system of emergency communications; and a multispecialty staffed 24 hour emergency service equipped to handle major casualties and backed up by the appropriate specialty services.[7]

If there is to be an improvement in injury and survival statistics, as well as in Phase I care, there must exist a highly coordinated and sophisticated ambulance emergency care system.[8] However, the quality of emergency care delivered is directly related to the skill, training, and capability of those who administer it and not solely to the equipment and systems available.[9]

Even where there are trained emergency care technicians available, the care delivered may be inadequate or even harmful because of inconsistencies between training and performance, or inadequate recognition of the signs and symptoms of injuries or disease.[10] These failings may have a direct and negative effect on the appropriateness of treatment.

In many states there are minimal or no standards for the training of ambulance attendants, and only recently has attention been drawn to this serious gap in the medical care system by varying agencies.[11] However, a growing awareness of the lack of training available for Phase I emergency technicians has led to the development of various training programs.[12]

In 1970, the United States Department of Transportation in conjunction with Dunlap Associates released the course curriculum for an 81-hour Emergency Medical Technician-Ambulance (EMT-A) course which was to serve as a standardized course for use in all states. The New Haven EMT-A training program was initially developed under the aegis of the Yale Trauma Program to provide the best possible training for ambulance attendants within the New Haven region, improve the quality of care delivered, and increase interagency cooperation and communication. Regulations established by the State of Connecticut, effective January 1, 1974, required that all technicians and drivers employed by commercial ambulance services be licensed, with licensure dependent upon successful completion of the standard 81-hour EMT-A course and a 20-hour refresher course every second year.[13]

EMT's are responsible for supporting life and reducing morbidity while transporting the patient safely and expeditiously to the care of a physician. In the training course, EMT's receive basic training in the recognition and treatment of medical, surgical, obstetrical and psychiatric emergencies. They are also trained to a limited extent in communications, extrication, medico-legal problems, and the safe driving of emergency vehicles.

In November of 1972 after approximately 200 EMT's had been trained in New Haven, there was a subjective impression that their diagnostic accuracy and therapeutic intervention had improved. However, this impression was not demonstrable through objective information. There were no existing prospective studies of EMT performance available. To justify the continued expenditure of time and funds on training, information on the quality of care rendered by graduates of the EMT-A training course was obviously necessary. Futhermore, it seemed reasonable that any alterations in the basic 81-hour EMT-A course and the 20-hour refresher course should be based both on documented performance deficiencies and on identifiable special local requirements.

The Yale Trauma Program, with funding from the Commonwealth Foundation of New York, developed and carried out a performance evaluation of the approximately 200 Emergency Medical Technicians who had been trained in the New Haven EMT Training Program. All EMTs in the sample were trained according to the standard 81-hour curriculum by the same group of four instructors, although four separate classes were involved. The performance of these EMTs was surveyed for approximately 3,300 cases transported by them to the Emergency Service (E.S.) of Yale-New Haven Hospital over a six month period. Data collection was carried out by interviewers present in the E.S. 24 hours a day, seven days a week. A 14 page form was used to collect patient socio-demographic data, relevant historical information, observed signs and symptoms, EMT clinical impression, EMT treatments, and the physician's emergency service diagnosis and patient disposition. This information was then correlated with a set of standard criteria developed through the use of standard EMT training course texts and revised by a physician panel. The data were then analyzed to determine the accuracy of EMT diagnosis (as compared to the physician's diagnosis), the appropriateness of EMT-provided treatments (as measured against the standard criteria for care, i.e., mandated treatments) for specific diagnostic groups, and the frequency with which EMT treatments provided were consistent with the diagnosis when the technician was correct in his initial clinical impression. Approximately 1,800 cases in the sample group could be analyzed using the "mandated treatment" methodology.

Several important observations were made during this initial study which served as the pretest for the present project. The first was that the diagnostic accuracy of EMTs ranged widely over varying diagnostic groups, tending to be somewhat higher in surgical or trauma cases as opposed to medical or non-trauma cases. However, within the broad range of trauma, diagnostic accuracy varied widely, with lacerations and fractures of the ankle scoring well above 80%, while fractures of the femur and clavicle scored below 20% accuracy. The second important observation is that in a significant number of cases in which the EMT was incorrect in his clinical impression, he nonetheless provided the appropriate treatment. In analyzing the constellations of signs and symptoms recorded by the EMT, it was apparent that he was treating the signs and symptoms appropriately, although he was unable to integrate them into the correct diagnosis. This was particularly evident in certain medical problems, such as pulmonary edema and myocardial infarction. The consistency with which treatments were given to a particular diagnostic group having a mandated treatment also varied widely, being exceedingly high in many trauma groups, but quite low in certain medical groups, particularly cerebrovascular accidents (stroke). In this situation, it was hypothesized that the EMT may have had an inadequate understanding of the physiologic basis of the problem, and hence failed to appreciate the importance or significance of the required treatment.

Of particular concern was the observation that *many cases were correctly diagnosed but incorrectly treated.* The data were further analyzed to determine what possible additional factors might mitigate against the EMT providing the known and accepted mandated treatment. Suggestive evidence was present that the presence of concommitant factors such as alcohol abuse, psychiatric conditions, or drug addiction were associated with inappropriate or inadequate treatment in these patient subgroups.

It was also hypothesized that lower socioeconomic patient subgroups were receiving less adequate care than were those of higher socioeconomic standings. Tacit in this assumption was the implication that there would be a difference in treatment patterns associated with differences in race or ethnicity. Analysis of the data showed that patients in the lowest socioeconomic (SES) quintile received a slightly higher rate of appropriate treatment than did those in the highest socioeconomic quintile. A possible explanation for this finding was that EMTs may have found it difficult to play the role of a professional when dealing with patients in the higher socioeconomic levels, but were able to do so readily when dealing with patients in the lower socioeconomic levels. If so, they would be likely to act in a more professional manner and thereby provide more appropriate care for patients in the lower SES groupings. An outgrowth of this hypothesis was that the socioeconomic status and various motivational factors of the EMT might also play an important role in determining which EMTs would perform with a high level of appropriateness and which would not.

The need to replicate this study and to examine the various hypotheses proposed set the stage for development and implementation of the present research effort.

EMT Evaluation

Since the inception of the DOT-specified EMT training curriculum, most efforts to assess EMT performance have been limited to paper and pencil testing. This is routinely carried out as a mechanism for determining successful completion of the course and is a low-cost method of evaluation. Several states have developed written assessment tests for state certification, and the creation of a National Registry for Emergency Medical Technicians has fostered the concept of a nationally accepted standard of performance on a standardized test.[14]

Truelove and Abercrombie[15] of Alabama have developed a multiple choice test, of approximately 300 items, which is based upon tasks that practicing EMTs have identified as being both frequently performed and important aspects of their work. In validating the test against the ratings of EMT supervisors, there was seen to be a high correlation between the supervisor's perception of the EMT's ability to function and raw scores on the written test. In general, however, written tests have an unknown correlation with actual performance. In an effort to deal with the skill requirements of the EMT several practical examinations involving both simulated case management and basic skill testing have been developed.[16] Disadvantages of this approach are the variable and frequently high cost of simulation testing, the highly controlled nature of the simulations with a resultant possible lack of task realism, and the unknown correlation of performance on simulation testing with field performance. In the final anlysis, it is the clinical or field performance of the EMT which is of paramount importance, and any attempt to evaluate EMTs must either deal directly with field performance, or demonstrate a strong correlation between the evaluative methodology used and actual field performance.

Background

All provision and planning of Emergency Medical Service in Connecticut fall under the aegis of the Office of Emergency Medical Services (OEMS) in the State Department of Health by virtue of Public Act 74-305. This Act was promulgated and passed by the state legislature in order to carry out the mandate provided by Public Law 93-154, the Federal EMS Systems Act of 1973. While this evaluation project was not done because of the State EMS program, it was carried out in the midst of these developments, and there were several areas of common concern where the study staff interfaced directly with OEMS.

Changes instituted by the State during data collection which had the most direct effects on the level of patient care were the rigid enforcement of 1) a complete vehicle equipment inventory, and 2) the use of only trained and licensed EMTs in the ambulance patient compartment.

The emphasis on rational and coordinated planning promulgated by OEMS served as a theme for the EMS providers in the greater New Haven area. This atmosphere augmented by numerous planning and development meetings between the project staff and the providers prior to data collection, resulted in a smooth implementation of the interview phase of the study.

The three hospitals and most of the ambulance providers involved in the study were from the South Central Connecticut region of the EMS system. The majority of emergency ambulance cases arriving at Yale-New Haven Hospital (YNHH) and the Hospital of St. Raphael (HSR) in New Haven originated in the communities of New Haven, East Haven, North Haven, West Haven, Branford, Guilford, Hamden, Orange and Woodbridge, a region usually considered to be a medical trade area. Located at the intersection of three major interstate highways, this area encompasses 136.3 square miles with a total population of approximately 400,000, 85% of which is urban and suburban. While almost 14% of the total population of the area is non-white, the City of New Haven itself has experienced an increase in non-white population during the last decade from 14.9% to 34.8%. This minority population includes a rapidly increasing Spanish-speaking population (9%).

Coincident with this increase in minority population, the City of New Haven experienced an overall population decline of 9.5% over the past decade. During this period, the total area experienced a 12% rise in population largely confined to the suburban communities. The urban center is experiencing an outward migration of whites to the surrounding towns and inward migration of black and Spanish-speaking minorities. Additionally, Yale-New Haven Hospital and the Hospital of St. Raphael attract a significant volume of cases from smaller communities `more peripherally located such as North Branford, Wallingford, Bethany, Clinton and Madison.

Largely due to the presence of Yale-New Haven Medical Center, the area is high in physician and allied health resources. As a result of this concentration of tertiary health services, the New Haven area receives a number of ambulance transfers involving acute patients for the spinal cord, cardiac surgery, or burn treatment units.

In terms of the availability of health services and access to these services, New Haven and the surrounding area is seen as a relatively "health rich" community. The physician/population ratio for the region is 31.8 per 1,000 population. Although dramatically above the national average, this ratio tends to be inflated by the presence of a large medical school. Encompassed within the area are three hospitals with a total of 2,122 beds* (a bed population ratio of 5.3 per 1,000 population), three health maintenance organizations, and approximately 250 organizational providers of health or health-related services.

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* This includes 711 Veterans Administration beds in West Haven

Of the three area hospitals, two are located in New Haven. The Hospital of St. Raphael is a 446 bed hospital located in the center of New Haven. Approximately 160 patients are treated in the emergency service each day, with about 12-15 ambulance visits.

Yale-New Haven Hospital is a 965 bed teaching hospital, one of the two largest in the State, and is located in the center of New Haven. YNHH treats approximately 250 patients daily in the Emergency Service, and receives an average of 25-30 ambulance visits per day. The YNHH Emergency Service has the largest E.S. caseload in the State.

Both hospitals are staffed and equipped to deal with medical, surgical, psychiatric, obstetrical, and pediatric problems 24 hours a day. Extended care services include medical, surgical, neurosurgical, and pediatric intensive care and coronary care units. Of the two hospitals, YNHH treats the majority of major trauma cases because of its greater size and degree of specialization and easy access from interstate highways. HSR is a Catholic hospital which may have an effect upon the demographic background of patient's being brought to the emergency service by ambulance.

Ambulance services for the seven-town region are provided by six commercial companies. Flanagan and New Haven Ambulance companies are located in New Haven and also service Woodbridge and Orange. They are the largest companies in the region and provide the majority of services. Murray's Ambulance in Hamden and North Haven Ambulance of North Naven are subsidiaries of New Haven Ambulance. Flanagan Ambulance has four vehicles, while New Haven and its subsidiaries have six vehicles. The two remaining companies, Nutile's Ambulance and Connecticut Ambulance, provide service for the cities of East Haven and West Haven, respectively. Both these companies are smaller than the two New Haven Ambulance services with Nutile's having two vehicles and Connecticut three. The six ambulance companies receive about 60-70 calls per day, with 35-40 of them requiring transportation to an emergency service. While the majority of data collected were from commercial companies, numerous volunteer and municipal providers from the surrounding areas utilize the New Haven emergency services. It has been estimated that ambulance runs of all types, both routine and emergency, amount to approximately 22,000 a year for the area, with estimates varying between ⅓ [17] and ½ [18] of these being non-emergent cases. While certain differential patterns of E.S. utilization emerge between HSR and YNHH, based mainly on demographic, geographic and religious characteristics, it has been assumed for this study, with some justification, that the choice of emergency room by ambulance vehicle is essentially random.*

The third hospital in the survey was Milford Hospital, a 150 bed general hospital with an annual emergency service caseload of 32,000. Milford has a population of approximately 53,000 and draws cases from a population base of about 63,000. It is serviced by a single commercial company, Chamberlain's Ambulance Service.

The training program for the EMT-A 81-hour course which was established at YNHH in 1970, draws students from New Haven and the 12 contiguous or nearby towns. It is basically the ambulance services for this larger area which utilize the emergency facilities of YNHH. The vast majority of Emergency Medical Technicians surveyed during the course of the earlier study were graduates of the New Haven 81-hour EMT-A course.

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* In emergency ambulance cases, the ambulance technician tends to bring the patient to the closest facility. That is, the preferences of the patient are not as great a factor as in walk-in cases. The proximity of the two hospitals therefore justifies the assumption of relative randomness

A survey conducted in 1971 under the auspices of the Yale Trauma Program [19] provided the following information about Connecticut ambulance attendants. Of those attendants employed by a commercial ambulance service in Connecticut, 55% were employed full-time by the services and 45% were employed part-time. The commercial attendants in this survey were young, with a mean age of 26 years. This contrasted with the mean age of 34 years for municipal attendants, 38.5 years for voluntary attendants, and 40 years for hospital based attendants. The mean hourly pay rate of commercial attendants in Connecticut in 1971 was $2.00 per hour; for municipal employees, the rate was $4.83 and for hospital-based, $3.25. Except for hospital based attendants, the payment of shift differentials is not common.

In this same survey, attendants employed by commercial services had a mean of 4.9 years of experience in emergency medical work, as compared with the experience of municipals of almost 11 years. This indicates a fairly rapid turnover in the younger age groups in the commercial organizations.

III. Project goals and hypothesis development

The first research goal was to identify statistical factors which would adequately profile Emergency Medical Technician Phase I performance. The findings of the initial study regarding the task completion rates of EMTs were highly controversial. Using a one-page self-administered form which was tested in the initial study, a larger number of cases would be required in this study with particular reference to certain diagnostic categories. While the initial study showed that less than 50% of all fractures were treated appropriately, there existed a wide range of rates of appropriate treatment between different diagnostic categories of fractures. For example, while 83% of all fractured ankle cases were treated appropriately by the EMT, only 9% of fractured clavicle cases were treated appropriately. The size of the original sample was such that it precluded tests of statistical significance at this diagnosis-specific level of aggregation. To effectively influence training programs, and thus influence performance, it is essential that the number of cases in each diagnostic category be sufficiently large to permit adequate analysis of individual diagnoses, avoiding the inherent biases and lack of sensitivity observed by aggregating diagnoses such as "all fractures". The more detailed level of analysis would also serve to highlight more clearly problem areas which require revision of the 81-hour D.O.T. course or the 21-hour refresher course.

In the earlier project, a cursory analysis of other factors which influence EMT performance produced several hypotheses which the present study intended to test given the increased number of diagnostic-specific cases. The presence of concomitant conditions, particularly those which carry a "social stigma", appears to have a negative effect on the appropriateness of EMT-provided care. The results of the initial survey suggested that the high incidence of psychiatric conditions, drug use, and alcohol abuse in the patient sample had a measurable and negative effect on the rates of appropriate care delivered by the EMT. For example, while 67% of all laceration cases in the initial study were appropriately treated, only 58% of those which concomitantly demonstrated psychiatric, drug use, or alcohol-related diagnoses were treated appropriately.

According to hypothesis 1, then, inadequate treatment of patients with these concomitant conditions may be related to a perceived "abuse" of ambulance services. The EMT may see these conditions as patient self-destructive behavior which results in the EMT having to perform "another run", often for non-severe conditions, and with little or no positive feedback from the patient. In this setting, the EMT may be less apt to look for subtle signs and symptoms of serious disease or injury and may not sense the gravity of signs and symptoms he does observe. He may also be disinclined to treat such signs and symptoms even if observed. Important signs and symptoms are often masked by more obvious presenting conditions, particularly alcoholism or psychiatric disease. This, combined with a lack of incentive to treat the ungrateful or even hostile patient, may result in a substantial incidence of inappropriate treatments. Two limitations of the initial study prevented complete testing of this hypothesis. The small number of cases with diagnoses whose treatment could be "mandated" which also exhibited any of the three concomitant conditions listed above resulted in a sample size too small to analyze except for the "mandated" category of lacerations. In addition, the diagnosis of alcoholism collected in the initial survey did not differentiate between chronic alcoholism (and its physiological complications) and acute alcoholic intoxication. Differentiating between these two diagnoses might provide additional insight into possible explanations for the poor performance already observed in "alcohol use" related cases. It was hypothesized that the concomitant presence of acute alcoholic intoxication may influence EMT performance by masking important signs and symptoms, whereas chronic alcoholism may negatively influence EMT motivation to treat effectively.

The second hypothesis to be tested postulates that the geographical location of patient pick-up may influence the appropriateness of care delivered. A related hypothesis is that the socioeconomic status and the race of the patient himself may influence the adequacy of the EMT's performance in response to that particular condition. Both of these hypotheses developed out of attempts in the initial study to understand inconsistencies in the performance of EMT's which could not be explained by training deficiencies. While both hypotheses deal with the effects of the EMT's perceptions of the patient, it is thought that these perceptions may be affected by two mechanisms. Hypothesis 2 deals basically with the geographical nature of Phase I emergency services in an urban setting. It is assumed that each neighborhood has a certain character which the EMT learns by experience, and which may affect his expectation of the type of case to be encountered. Such "pre-conditioning" could have an effect on EMT treatment under certain circumstances. Hypothesis 3 deals with the same types of perceptions and "stereotyping" of a particular case which could effect performance. The action of this factor is accomplished through the direct patient encounter and not the integration of preconceived notions about the neighborhood. Clearly, such factors as race and perceived social and economic status of the patient are possible sources of effect, positive or negative, on appropriate treatment rates.

The second major purpose of the project involved further development of the screening method developed for identifying individual cases in which an EMT exhibited highly appropriate or inappropriate care.

While a mechanism had been developed to produce aggregate performance information by company on a weekly basis, further elaboration was needed to produce the same information for individual EMT's in order to provide the feedback necessary to improve the quality of Phase I performance.

The third major purpose involved the refining of criteria with which to judge the appropriateness of care. The criteria defined in the previous study appeared effective in measuring the task completion rates (performance) of an EMT, but it was felt necessary to re-examine the criteria, using a panel of local experts, to ensure that the criteria were in keeping with present training concepts and rising levels of performance expectations.

The fourth major purpose involved identifying changes needed in the EMS System and in EMT training courses, implementing such changes, and evaluating the impact of these changes on EMT performance. Such modifications should be documented and analyzed using a series of controlled interventions. In addition, the various modes of continuing education and their effect on performance were planned for investigation using a matched control group and a series of "test" groups. The "test" groups planned were a peer review group, individual EMT critique by a physician, a weekly case review class taught by a physician, and individual EMT feedback on inappropriate care through the owner or manager of an individual service. Continued education was felt to be an integral part of improving EMT performance. While a refresher course every two years and/or monthly seminars are undoubtedly of some value, they may be temporally too remote to the EMT's daily case work to be meaningful. The ideal theoretical mechanism for instruction would be an immediate, case-by-case feedback system. This appeared impractical, but a variation on this approach seemed feasible.

Methodology

The training program for the EMT-A 81-hour course was established at Yale-New Haven Hospital in 1971, and draws students from over 18 towns surrounding New Haven. The majority of EMT's surveyed during the study were graduates of the New Haven course. Certain background information for every EMT trained in New Haven was collected through a registration form completed at the beginning of each course. From this information a demographic and training profile of all EMT's (trained in New Haven) was compiled. Data collected through the registration form included birth date, home address, race, sex, marital status, education, health and emergency medical training, present and previous employment and EMS organizational affiliation (service and type). The three types of services in the New Haven region are commercial, municipal, and volunteer. The municipal service, however, is composed of a small number of employees (5) and a large number of supporting volunteers. For purposes of this evaluation it appeared most appropriate to treat this service as though it were a volunteer group. It was hypothesized that there would be both motivational and organizational differences in these services and that might account for differences in rates of appropriate treatments.

As of June, 1975, 462 EMT's in nine classes had been trained using the standard Department of Transportation-approved 81-hour course curriculum. Class size ranged from 35 to 60 students. Three-hour sessions were held twice weekly for a total of 13 weeks. All of the instructors were physicians teaching in their area of speciality, except where non-physicians were required (legal, religious, extrication subjects). The majority (95%) of students were male, and most had a 12th grade education level (57%). Just over half of the students (54.4%) were between the ages of 18 and 30 with most of the remainder (40.2%) between 30–45 years.

Of the 462 EMT's trained, 289 (65%) reside in New Haven and the eight contiguous communities of the City. These include West Haven, East Haven, North Haven, Hamden, Orange, Woodbridge, Branford and North Branford. Tabulation of the residence of EMT's with regard to individual cities and towns shows a relatively broad distribution, with New Haven having 15% followed by Hamden with 9%.

Another demographic characteristic, determined by the address of the EMT, was the socioeconomic status (SES) of the individual. A recent study by New Haven Health Care, Inc.[20] described the socioeconomic characteristics of New Haven and several of its contiguous communities. The study defined SES as " . . . a composite variable incorporating median family income, per cent of population 21-years old and older with less than 12 grades of education, per cent of employed males in unskilled, semi-skilled, and service occupations, per cent of occupied dwelling units with 1.01 or more persons per room, and the per cent of children under 18 years of age and living with both parents."

By using United States Census information (as did the New Haven Health Care Study), it was possible to determine the distribution of EMTs within the five E.S. categories (quintiles): High SES, upper middle SES, middle SES, lower middle SES, and low SES (Graph 1).* The distribution was fairly even, with the middle SES having a slightly higher proportion (29%). Of note is that all of the EMTs in the low SES category reside within New Haven.**

A broad spectrum of primary occupations were represented. Significantly, only 18% of students considered themselves full-time Emergency Medical Technicians (Table a). One reason for such diversity of occupation was the presence of a large number of volunteers in the training courses. "Fireman" was the most frequent full-time occupation (25%), while part-time employment varied greatly. Of the total, 70% were part-time EMTs with no other occupation having more than 6% representation (Table b). A more accurate representation, however, is obtained by comparing the number of full-time EMTs with part-time EMTs (Table c). It was found that 57% performed on a full-time basis while 43% worked part-time.

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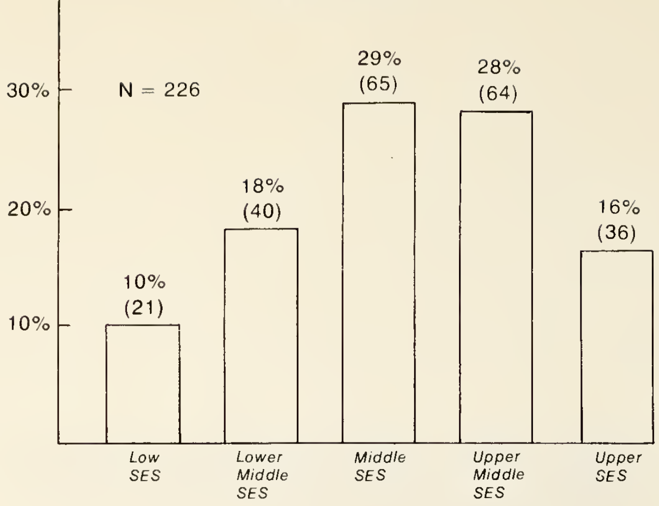
* SES could be determined for only 226 EMTs

** Table d and Graph 2



Graph I: SES

Table a: Full Time Occupation

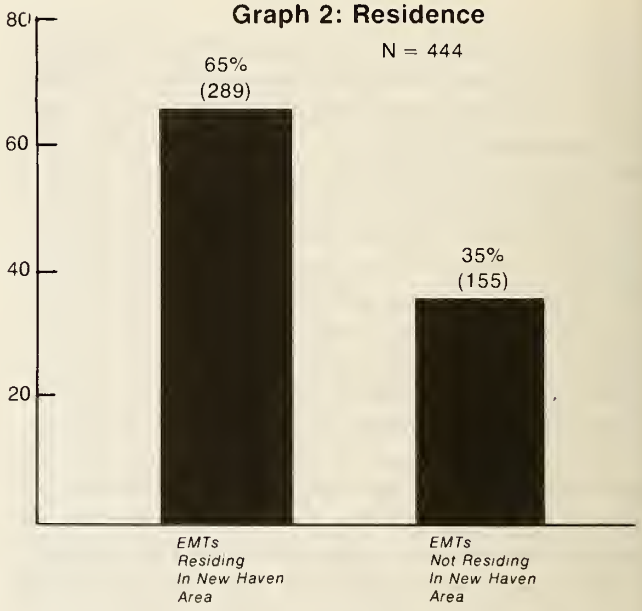
Firemen	25%	(111)
EMT	18%	(78)
Craftsmen	14%	(64)
Professional and Technical Workers	7%	(31)
Policemen	6%	(28)
Students and Unemployed	6%	(27)
Service Workers	5%	(22)
Sales Workers	4%	(19)
Transport Equipment Operatives	4%	(18)
Managers and Administrators	3%	(15)
Operatives Except Transport	2%	(10)
Laborers	2%	(10)
Clerical Workers	2%	(8)
Private Household Workers	> 1%	(2)
Total	100%	(443)

Table b: Part Time Occupations

EMT	70%	(58)
Craftsmen	6%	(5)
Service Workers	5%	(4)
Clerical Workers	5%	(4)
Transport Equipment Operatives	4%	(3)
Sales Workers	4%	(3)
Laborer	2%	(2)
Firemen	2%	(2)
Professional and Technical Workers	1%	(1)
Farm Laborers	1%	(1)
Total	100%	(83)

Table c: Full Time EMT vs Part Time EMT

	Full Time		Part Time	
EMT Private	56%	(72)	44%	(57)
EMT Municipal	86%	(6)	14%	(1)
EMT Total	57%	(78)	43%	(58)



Graph 2: Residence

Table d: Residence

New Haven	15%	(66)
Hamden	11%	(48)
West Haven	9%	(41)
East Haven	9%	(38)
North Haven	7%	(30)
Woodbridge	6%	(25)
Branford	5%	(23)
North Branford	3%	(15)
Orange	1%	(3)
Total	65%	(289)

The majority of students (96%) had received some form of prior health training on a formal basis. Most had completed the Basic Red Cross (64%), while 51% completed the Advanced Red Cross Course, and slightly under half (47%) had received CPR training. The majority of students (15%) had received training in the National Ambulance Training Institute Course. Other training included Medical Self Help (8%), training in the Armed Forces (6%), and extrication courses (4%).

Half (50%) of all students were affiliated with commercial ambulance companies, while others were evenly divided between municipal and volunteer organizations.

It should be noted that there are not conventional municipal services existing in the immediate study area. Some services consider themselves "municipal" as the vehicle and supplies are maintained by the community. The EMTs, however, are reimbursed on a per-call basis. In the South Central Connecticut Health Services area there is only one municipal service employing five technicians, and this has a large back-up staff of volunteers.

Certain variables which are important to develop an accurate profile of EMTs were not collected with consistency. For example, the number of hours worked was not collected from early cases, and when collected often reflected hours worked in an occupation other than as an EMT. The number of individuals listing their full or part-time occupation as EMT and also recording number of hours worked was not large enough to produce a meaningful statistical analysis of this variable. Certain estimates could be made of this variable, however, through subjective impressions of the working hours of EMTs by the core staff and the interviewers. These impressions came from first-hand knowledge of the ambulance business and conversations with both the EMTs themselves and several managers of ambulance services. Full-time EMTs work at least 50 hours per week. Those that work less usually hold a part-time job to supplement their income, which in the case of most EMTs is low. In either case, the total number of working hours for an individual employed as an EMT is usually over 50 per week, and ranges up to 80 to 90 hours.

A general profile of the average EMT can be drawn from these data. He is a married, white male, approximately 31 years old and has a 12th grade education. He lives either in New Haven or one of its close suburbs and is in the middle of the socioeconomic scale. He works two jobs and averages approximately 60 working hours per week. Previous health training usually includes the Basic Red Cross First Aid Course and usually the American Red Cross Advanced Course and/or a CPR course.

An additional class (10th) was trained by June, 1975, but their demographic characteristics were excluded from this profile because of the special composition of this class. Almost all students in the class, sponsored by the City of New Haven, were affiliated with the New Haven Office of Manpower. Many were unemployed, and others were volunteers in various institutional health agencies and never intended to use their training in an ambulance setting. Of this class 55% were non-white and 62% were female, as opposed to 2% non-white and 5% female in all previous classes.

It should also be noted that not all graduates of the New Haven EMT Course participated equally in the study. Some students incorporated in the demographic profile did not transport any cases during the study, and others took part with low levels of frequency.

General Methodology

The methodology used in the present EMT performance evaluation employed a single-page data collection instrument which was completed by a member of the EMT team under the guidance and supervision of an observer. The form was completed in the Emergency Service as soon as responsibility for the patient had been transferred from the EMT team to the Emergency Service staff. The observer assisted the EMT in completing the form, ensuring that all questions were answered and all available data recorded. Observers were present in the Yale-New Haven Hospital (YNHH) Emergency Service 24-hours per day, and initially 24-hours per day at St. Raphael's Hospital (HSR), although coverage was reduced to 16 hours per day (night shift omitted) after two weeks. EMT data was validated by the observer during the intial phase of the project using a homoform on which those treatments which could be seen, such as dressings and splints, were recorded. The EMT would record data in the areas of history and physical assessment, clinical impression or diagnosis of the patient's condition, and the treatments rendered. This information was then compared with the Emergency Service medical record for consistency of observations and accuracy of diagnosis. The Emergency Service physician's diagnosis and the disposition of the patient were recorded on the back side of the EMT data collection form.

A comparison was made between the physician diagnosis and the EMT diagnosis to determine EMT diagnostic accuracy. The appropriateness of the EMT provided treatments was determined by comparison with a set of mandated treatments (see following section) based on the physician's diagnosis. Analytical factors were developed and calculated to describe EMT diagnostic accuracy, over- and under-diagnosis, selectivity and specificity, treatment consistency, and over- and under-treatment (see analytical factors section).

Mandated Treatments

The mandated treatment criteria previously mentioned were developed by abstracting the standard EMT course texts: (*Care and Transportation of the Sick and Injured Patient*, American Academy of Orthopedic Surgery; *Emergency Care*, Brady Company) and course presentation materials. Since a core of 4 physicians and 1 EMT instructor had conducted almost all of the training sessions, the content of material presented in EMT classes was consistent for all EMTs trained prior to the performance evaluation. The treatments which were selected as "mandates" were those which were felt to be required in essentially all cases with a given diagnosis. The list of mandated criteria appears in Table I. Mandated treatments range in complexity from merely the provision of reassurance (in cases of URI, asthma, psychiatric disturbance), to the provision of multiple treatments including appropriate immobilization of fractures, positioning of the patient, and administration of oxygen. The criteria were reviewed by the EMT course-instructor staff consisting of a surgeon, anesthesiologist, internist, orthopedic surgeon and EMT instructor for consistency with standard teaching and practice principles. The final criteria are explicit and are felt to be appropriate for the evaluation of all cases falling within the designated diagnostic category.

In using the criteria it should be cautioned that they provide only a framework by which performance may be initially screened as either appropriate or inappropriate. Apparently inappropriate cases require additional review to determine the actual appropriateness or inappropriateness of care provided. It should also be pointed out that provision of a "treatment" may indicate that a specific procedure was carried out, but in no way indicates the quality of the task performed. In this sense, use of mandated criteria provides the reviewer with a "task completion rate", but not a quality of performance rating. A mandated treatment may, rarely, be contraindicated, as for example the administration of oxygen to a patient with a myocardial infarction who does not want to receive oxygen. In auditing such a case, the failure to administer oxygen would be noted as a performance deficit and the case would be flagged for review. The well-trained EMT, however, should note on his record that the patient refused the appropriate treatment, and the apparent inadequate performance would not, on review, constitute inadequate treatment.

Analytical Factors

To evaluate the performance of EMTs, it is necessary to gather patient-specific data concerning the EMT clinical impression (i.e. EMT diagnosis), EMT treatments, and the physician diagnosis. These data may then be aggregated by physician diagnostic groups for analysis. A variety of analytical factors were developed to describe EMT diagnostic and therapeutic practices. The central element of the analysis rests upon the creation of a 2 × 2 matrix which displays all cases with a given diagnosis, separated into those which were not correctly diagnosed by the EMT and those which were or were not correctly treated by the EMT according to the mandated criteria for that diagnostic condition (Figure I).

In this matrix, the A cell represents those cases which were both correctly diagnosed and correctly treated by the EMT according to the mandated treatment. Cell B represents those cases which were correctly diagnosed, but which failed to receive the mandated treatment. Cell C represents those cases which were incorrectly diagnosed, but which nevertheless received the mandated treatment. Cell D represents those cases which were incorrectly diagnosed and which failed to receive the mandated treatment. It may be seen that the sum of cells A and C represent the total number of cases with a given diagnosis which were correctly treated, while the sum of Cells A and B represents the total number of cases with a given diagnosis which the EMT correctly diagnosed. Conversely, the sum of Cells C and D represents the total number of cases incorrectly diagnosed, and the sum of Cells B and D represents the total number of cases which failed to receive the treatment mandated for that specific diagnostic group.

It is to be anticipated that the EMT will not diagnose all cases of a given condition which the physician diagnoses, and will also include cases which the physician considers to belong to another group. In effect, there are two sets of cases, one constituting the physician-diagnosed cases and the other constituting the EMT-diagnosed cases. The two sets overlap by the sum of factors A & B. The subset of physician-diagnosed cases which were not correctly diagnosed by the EMT constitutes the sum of factors C & D. The subset of EMT diagnosed cases not also diagnosed by the physician constitutes a third factor, $(EDx - (A+B))$. It is important to know the total number of cases an EMT diagnosed to determine his diagnostic accuracy.

The diagnostic factors which were developed are as follows:

1. X represents the diagnostic accuracy and equals the number of cases both the physician and EMT diagnose divided by the total number of cases the EMT diagnoses $(\frac{A + B}{EDx})$. This factor gives the accuracy of EMT diagnoses using physician diagnosis as the standard. As X approaches 100%, EMT diagnostic accuracy increases toward the optimum.

2. X′ represents the number of cases which the EMT underdiagnosed and equals the number of physician-diagnosed cases minus the number of cases where physician and EMT diagnosis agree, divided by the number of physician-diagnosed cases $(\frac{N - (A + B)}{N})$. This reveals the extent to which the EMT is underdiagnosing a given condition. As X′ approaches O, there is less underdiagnosis. When $(A + B)$ approaches N, $[N - (A + B)]$

approaches 0 and the optimal level of diagnostic accuracy is achieved. While underdiagnosis should ideally approach 0, the same is not true for overdiagnosis.

3. X'' represents EMT overdiagnosis and can be derived by subtracting the number of times the physician and EMT agree on the diagnosis (A + B) from the number of times the EMT makes the given diagnosis, whether correct or not (EDx), and then dividing by the number of times the EMT makes the diagnosis (EDx). X'' indicates the frequency with which the EMT diagnoses a condition which does not exist. As X'' approaches 0, overdiagnosis becomes less prevalent. For some conditions X'' should remain high (e.g. fractures, especially of spine, pelvis, and long bones; myocardial infarction, etc.), while for others it should approach 0 (burns, lacerations, hyperventilation syndrome). Where failure to diagnose a condition may be associated with possible serious sequellae resulting from inadequate treatment, overdiagnosis should be prevalent. Where diagnosing a condition as present may prompt the EMT to administer a potentially deleterious treatment if the condition is not in fact present, overdiagnosis (X'') should approach 0 (e.g. diagnosing a true myocardial infarction as "hyperventilation syndrome" and treating the rapid respirations with rebreathing bag).

4. The factors $X' + X''$ can be used to determine EMT *selectivity* and *specificity* for a given condition. Selectivity is arrived at by subtracting X' from 100% (or X' as decimal from 1 & multiplying times 100), while specificity is arrived as by subtracting X'' from 100%. The selectivity factor provides an indication of the relative frequency with which the EMT does not diagnose something which is not present (i.e. high selectivity indicates a low false negative rate). The specificity factor indicates the frequency with which he does not miss diagnosing a true positive case (i.e. high specificity indicates low false positive rate).

The treatment factors developed are as follows:

1. The treatment consistency (Y) for the EMT can be derived by dividing the total number of cases appropriately treated by the EMT by the total number of cases diagnosed by the EMT (EDx). If the EMT treats solely on the basis of his own diagnosis, one would anticipate the Y would be consistently high. As Y approaches 100%, treatment frequency becomes more acceptable, with 100% being the optimal level of care based on EMT diagnosis.

2. A more significant factor is the total number of cases which were appropriately treated which fell within the physician-diagnosed group. This is represented by the factor Y' and equals the total number of cases appropriately treated by the EMT divided by the total number of physician-diagnosed cases (N). As Y' approaches 100%, appropriateness of treatment increases. In this particular instance the percentage of appropriate treatment is measured in cases where the condition actually existed.

3. If the signs and symptoms of a particular condition are obvious, one would expect the EMT and physician to agree on the diagnosis, and would further anticipate that the proportion of those cases appropriately treated would be the same as, or higher than, the EMT's basic treatment consistency rate. This factor is represented by Y'' and equals the total number of EMT appropriately treated cases where the EMT and physician agree on the diagnosis (i.e. cell A) divided by the sum of all cases they agree on (i.e. the sum of cells A & B). As Y'' approaches 100%, appropriateness of care improves. Optimal care for this group occurs when $Y'' = 100\%$. In this instance appropriateness of care is measured for those cases where the EMT was aware a particular condition existed as evidenced by his diagnostic agreement with the physician.

4. The factor Y''' represents the consistency of treatment for those cases which the EMT diagnoses as belonging to a particular set, but which the physician diagnoses as being a different condition. Y''' therefore equals the sum of all cases where the EMT's treatment is consistent with his diagnosis but where the diagnosis was incorrect (Rx EDx_i) divided by the sum of all EMT incorrectly diagnosed cases (EDx_i). If one creates a 2 × 2 matrix for the *EMT diagnosed cases,* this factor would be equivalent to the C cell divided by the sum of the C and D cells.

5. The EMT overtreatment rate (Y°) represents those cases which he appropriately treated based upon his own diagnosis but where the diagnosis he made was incorrect (Rx EDs_i) divided by the sum of all cases for which he provided the same appropriate treatment (Rx EDx_i + RxN).

6. The under treatment rate equals $Y^u = 1 - Y'$ and represents the percent of cases within a specific diagnostic group which the EMT failed to treat.

7. One can calculate the probability that an EMT will correctly diagnose a case and yet fail to provide the appropriate treatment. This factor is $(\frac{B_i}{Dx_i})$ and equals $\frac{B}{A + B}$. (Note that the "i" subscripts in the factor are present only to indicate a factor denoting inappropriateness of treatment and the Dx_i subscript in the factor is not equivalent to Dx_i used elsewhere). If making the correct diagnosis is an important step in the process of the EMT selecting the appropriate treatment, and if he understands the appropriate treatment for the condition diagnosed, one would expect this factor to be consistently low; that is, the number of cases both correctly diagnosed and appropriately treated would be quite large when compared to the number of all cases the EMT correctly diagnoses.

8. The probability that the appropriate treatment provided by an EMT is based upon a correct diagnosis is represented by the factor $(\frac{A_i}{Rx_i}) = \frac{A}{A + C}$. If making the correct diagnosis is a major factor in the EMT selecting the appropriate treatment, one would expect $\frac{A_i}{Rx_i}$ to be quite high. If, however, the EMT is frequently treating on the basis of signs and symptoms, as opposed to diagnosis, one would expect this factor to be low.

Example Case and Discussion

The following hypothetical case will illustrate the use and interpretation of the previously described factors:

An EMT has diagnosed 100 cases of what he thought were hip fractures during the past 6 months. Of these, he treated 70 cases appropriately. In all the cases the EMT transported, the physicians found 75 hip fractures, 60 of which were treated appropriately. The EMT and physicians agreed on the diagnosis for 50 of the cases and of these the EMT had treated 45 appropriately.

Hence: EMT diagnosed hip fractures = 100 (EDx)
M.D. diagnosed hip fractures = 75 (N)
M.D. + EMT agreed upon cases = 50 (A+B)

Using the population of hip fracture cases diagnosed by the physician, the following matrix (MAT_P) can be developed:

		Treatment	
		Approp. (+)	Inapprop. (−)
		A++	B+−
Diagnosis	correct (+)	45	5
		C−+	D−−
	incorrect (−)	15	10

Correct diagnosis; correct treatment = A = 45
Correct diagnosis; incorrect treatment = B = 5
Incorrect diagnosis; correct treatment = C = 15
Incorrect diagnosis; incorrect treatment = D = 10

Using the population of hip fracture cases diagnosed by the EMT, a second matrix (MAT_E) is developed:

A_E++ 45	B_E+− 5
C_E−+ 25	D_E−− 25

EDx = 100

Correct diagnosis; correct treatment = A_E = 45
Correct diagnosis; incorrect treatment = B_E = 5
Incorrect diagnosis; correct treatment = C_E = 25
Incorrect diagnosis; incorrect treatment = D_E = 25

Note that cells A_E and B_E retain their original values, while the value of C_E has increased (EMT over diagnosis and over treatment) as has cell D_E (over diagnosis only).

The following descriptive factors may now be calculated for the EMT:

Diagnostic:

X = diagnostic accuracy $= \frac{A + B}{EDx} = \frac{45 + 5}{100} = 50\%$

X′ = under diagnosis $= \frac{N - (A + B)}{EDx} = \frac{75 - 50}{75} = 33\%$

X″ = over diagnosis $= \frac{EDx - (A + B)}{EDx} = \frac{100 - 50}{100} = 50\%$

Case selectivity $= 1 - X' (100) = 1 - 0.33 (100) = 67\%$

Case specificity $= 1 = X'' (100) = 1 - 0.50 (100) = 50\%$

Treatment:

Y = overall EMT treatment consistency $= \frac{A_E + C_E}{EDx} = \frac{70}{100} = 70\%$

Y′ = treatment appropriateness for true positive cases $= \frac{A + C}{N} = \frac{60}{75} = 80\%$

Y″ = treatment appropriateness for EMT correctly diagnosed cases $= \frac{A}{A + B} = \frac{45}{50} = 90\%$

Y′″ = treatment approp. for EMT incorrectly diagnosed cases $= \frac{C_E}{C_E + D_E} = \frac{25}{50} = 50\%$

Y° = over-treatment $= \frac{Rx\ EDx}{Rx\ EDx_i + RxN} = \frac{C_E}{C_E + (A + C)}$

$= \frac{25}{85} = 29\%$

Y_u = under-treatment $= (1 - Y') (100) = (1 - 0.80) (100) = 20\%$

$(\frac{B_i}{Dx_i})$ = probability EMT will Dx yet Rx − $= \frac{B}{A + B} = \frac{5}{50} = 0.10$

$(\frac{A_i}{Dx_i})$ = probability EMT Rx + is based on Dx + $= \frac{A}{A + C} = \frac{45}{60} = 0.75$

In this case the EMT diagnosed 67% of true positive hip fractures ($\frac{A+B}{N}$), but was able to do so only by overdiagnosing the condition 50% of the time ($X'' = 50\%$), and overall diagnostic accuracy is only 50% (X). In addition, he failed to diagnose 33% of true positive cases (X'). His case selectivity is fairly good (67%) indicating that he has a relatively low false negative rate, while his specificity is lower (50%), indicating a higher false positive rate. That is, he is more prone to overdiagnose cases than he is to underdiagnose or miss cases.

His overall treatment consistency (for cases he diagnoses) is 70%, indicating that 30% of cases he diagnoses he still does not treat. This may be the result of lack of prominent signs and symptoms which would in and of themselves prompt treatment, lack of certainty in the diagnosis, mitigating circumstances (patient refusal, life-threatening condition, etc.), or other less obvious reasons. He treats 80% of true positive cases. Where both he and the physician agree on the diagnosis ("an obvious case of fractured hip"), his treatment rate rises to 90%. The implication here is that as the case becomes more clear (i.e. signs and symptoms more pronounced), his treatments became more frequent. He also tends to overtreat (29%) somewhat more frequently than he undertreats (20%). The probability that he will fail to treat a true positive case if he diagnoses it is quite low (0.10), and the probability that his correct treatment is predicated upon making the correct diagnosis is relatively high (0.75).

One can begin to appreciate the interplay between diagnosis and sign and symptom recognition in prompting appropriate treatment. Making the correct diagnosis is important and will usually lead to correct treatment, but sign and symptom recognition is also important and is responsible for 25% of all treatments. A disturbing finding in this example is that 7% of true positive cases (10% of all EMT correctly diagnosed cases) are correctly diagnosed but still not treated. The possible explanation for this will be discussed subsequently, but one reason could be that the presentation clearly suggested a hip fracture, but the signs and symptoms were not sufficiently severe to prompt treatment in and of themselves. This is referred to later as "the enigma of the B cell." The second problem area is in the D cell where 13% of cases were neither diagnosed nor treated. It is possible that these cases had few or absent signs and symptoms and might only be diagnosed by radiography. It is also possible that subtle signs/symptoms were present but were overlooked by the EMT. This will be referred to later as "the problem of the D Cell."

Research Project Organization

The initial project task was to establish the "Emergency Medical Services Evaluation Grant Advisory Committee." This was composed of both co-principal investigators, the official consultant staff, and one representative from each of the following: 1) Robert Wood Johnson Grant Consortion Advisory Council; 2) The Connecticut Advisory Committee on E.M.S.; 3) Milford E.M.S. Council; 4) New Haven Health Care, Inc. Research and Evaluation Committee; 5) State Department of Health; 6) EMT-A Association; 7) Ambulance Owners Association. This committee was charged with supervising grant activities, advising the principal investigators in appropriate areas, and facilitating the interfacing of the research operation with the related local, regional and state agencies. It was also responsible for establishing contact with the two regional data-use committees, the Milford E.M.S. Council and the Robert Wood Johnson Foundation Grant Consortium, and serving in a limited advisory capacity for them.

The Project Director was responsible for interviewing and hiring all personnel, establishing the central office facilities, supervision of all full and part-time staff, and coordination of meetings of the Advisory Board. He maintained lines of communications with the ambulance companies, emergency departments and ambulatory services agencies, record room personnel, emergency medical dispatching units (fire, police, etc.) and other related E.M.S. agencies. He was responsible for the arrival and presence of interviewers and quality controllers in their respective areas and distributed orientation information and documents to the above agencies. He arranged and directed a one-week clinical, on-location training session for the interviewers and quality controllers using a manual prepared for this purpose (appendix D.) Additionally, he was responsible with the co-principal investigators and the printer's representative for the development of the printed data collection instrument.

Members of the Advisory Board, and in particular the co-principal investigators, were responsible for refining the detailed methodology for the project, dealing with all aspects of organization, data collection, quality control, and analysis. Criteria for each diagnostic group and therapeutic modality were determined by the medical panel. The necessary software for data analysis was developed based on work accomplished during the previous study. The data collection instrument was also revised several times during the developmental phase in order to fit the precise data set and format desired.

Interviewers. The interviewers constituted a central element of the data collection scheme. Their role, by virtue of a 24-hour presence, was to make contact with each ambulance crew transporting a case to the emergency service.

All attendants, including those who were part-time, were instructed in the use of the data collection instrument in the actual clinical setting (E.S.).

The interviewers initially gathered data by interviewing the EMTs, then later by assisting them in form completion. It required several weeks to establish a satisfactory level of reliable reporting in all major diagnostic groups, even for those attendants with a high case frequency. It was difficult to train all attendants in reporting cases in all diagnostic areas during the interview phase; however, previous experience had demonstrated that the more complete the *supervised* portion of the data collection experience, the more reliable and thorough would be the data provided. For this reason, observers were maintained in the E.S. as much as possible (24°/day—YNHH, 16°/day—HSR) to assist the EMTs in data recording. As the research period continued, the attendants not only became familiar and proficient in completing the form for all diagnostic groups, but also came to expect this as one of the essential parts of patient transport.

Brief attempts in the past at retrospective data collection over even short periods (i.e. day personnel gathering data from the previous 12 hours) had met uniformly with failure. The attendants forgot essential details or confused cases, secondary diagnoses and more subtle findings were left out, or the personnel were not available because they worked a second or even third job. By maintaining full-time interviewers, the problem of retrospective collection was circumvented. An additional important reason for using interviewers was the identification, through interviewer feedback, of problems in the data set, form layout, or in lines of communication between study participants.

The use of a stratified or selective sample rather than a 100% sample was considered during the previous research project. This was rejected for three reasons: 1) With only one exception (laceration), the diagnostic groups would be too small for the analytical design; 2) Reporting repetition was felt to be essential for data quality maintenance and control; a stratified sample would not consistently reinforce the reporting act and would introduce a significant element of statistical unreliability. 3) With interviewers present, a 100% sample added only the nominal cost of processing the added cases, and did not affect personnel or other expenses significantly.

The role of a "quality controller" evolved during the previous research project in the form of a knowledgeable second-party check of each case for completeness, internal consistency of data, and consistency of data with the hospital E.S. data set. This function was originally carried out by Dr. Frazier, but with sufficient instruction and supervision, a research assistant was able to review all records. The quality controller required a substantial knowledge of emergency medical problems, presentations, signs and symptoms, diagnoses, radiological and laboratory findings, and medical shorthand and terminology to determine whether an EMT's observations and diagnosis were consistent with the emergency room physician's diagnosis. In this project, all cases were reviewed by the quality controller. Incomplete forms were completed by contacting the EMT, the dispatchers, or by consulting the hospital record as necessary. Inconsistencies in the data sets, if unresolvable, were turned over to the project director for evaluation, usually resulting in the case being rejected from the study.

Interviewer Training. All interviewers underwent four days of training from the Project Director. Considerable effort was expended to familiarize the interviewers with the functions of the E.S. in an effort to minimize any problems in interfacing with hospital or ambulance personnel.

One session in the training period was composed of a display of all equipment commonly utilized by the EMTs. Although all interviewers had some previous experience in emergency medical services, the recognition and use of this equipment was demonstrated to give the homoform reports a greater degree of validity. An ambulance vehicle was brought to the training session for the interviewer's inspection, and general procedures and policies related to ambulance dispatch, patient transportation and transferal of responsibility for patient care in the E.S. discussed.

Another major focus of the introduction involved the data collection instrument. Using the Training Manual as a guide, the interviewers were instructed in use of the data collection instrument and homoform. Hypothetical cases were created and sheets completed for these situations.

Data Collection Instrument. The basic data collection instrument (ambulance run report) was developed in varying stages from the original 14-page interview form used in the Yale Trauma Program study. The form (appendix B) evolved through a series of theoretical additions and deletions as well as test runs with each modification of the form using the previous data set collected during the interview survey to establish its comprehensiveness and validity. The final version was a three page snap-apart form with black carbon. The ambulance run report is printed on the front of each copy with the differences being color coding and shading (see appendix A). Certain sections were color-coded to facilitate the change from interviewers to self-assessment and allow easier recognition of a pertinent section. The color-coding served the additional purpose of providing for various types of first response. Thus all areas shaded "blue" were to be filled out by the first responder—usually the police. This aspect of the study was pilot tested in Milford, Conn. None of this information involves any clinical expertise, but rather simply documents the call and any information which an untrained observer could determine. The only clinically related information was the location and type of suspected injury and a general patient assessment.

The data collection instrument has 12 major sections, and includes 18 general types of data. These are 1) The patient identification information, 2) billing information, 3) run times, 4) pick-up location, 5) information on assistance, 6) chief complaint and history of present complaint, 7) presence and type of trauma, 8) time of illness (injury), 9) patient history, 10) observations at scene and en route, 11) location and type of injury, 12) signs and symptoms, 13) EMT clinical impression, 14) treatments rendered, 15) vehicle and EMT numbers, 16) nature of run, 17) run conditions and 18) additional remarks.

Section I contains information on the patient treated by the ambulance service. This information includes the patient's name (for identification and linkage purposes only), address (for geocoding purposes only), date of birth, sex, and race, as well as date of encounter.

Section II contains that information which is required by third party and private purveyors for billing purposes. This information is included to eliminate the need for the ambulance service to fill out yet another form, thus facilitating the data collection process.

Section III contains information on the dispatching of the emergency vehicle. This information includes the dispatch time, arrival time at the scene, departure time from the scene, and time of arrival at the hospital emergency room.

Section IV contains descriptive information about the scene, including the pick-up address, final destination location, nature of the scene, and description of the nature and type of the first response activity if any was provided.

Section V contains the first report of the incident requiring emergency medical services as received by the dispatcher; the chief complaint as stated by the patient upon arrival of the EMT; and an area to record any pertinent remarks and/or history regarding the incident which the EMT feels may prove useful to the emergency room staff. In addition, a small box in this section is available for noting prior alcohol use by the patient.

Section VI describes the mechanism of injury. If vehicular, the position of the patient in the vehicle, the vehicles involved, and the impact site. If non-vehicular, various types of trauma and mechanisms of injury are included.

Section VII provides an area to report the time of onset of injury or illness, and any history of previous major illnesses. It also provides an area where sixteen clinical observations of the patient's status may be recorded, both at the scene and any improvement or worsening of these conditions en route to the hospital. Fifteen major areas of the body can be designated by check boxes as having bone or joint soft tissue injury or as being the location of pain. A group of seven signs and symptoms follows which serves as a method of quick patient evaluation for the EMT. Finally, accurate recordings of pulse and respiration rates and blood pressure are noted.

Section VIII is for EMT clinical impressions (4). These are drawn from over 300 commonly occurring diagnostic categories as determined by incidence rates in the initial study. Included in this assessment are diseases of the heart, lung and airways, abdominal diseases and injuries, musculoskeletal fractures, dislocations or sprains, soft tissue wounds, amputations, burns, and miscellaneous conditions.

Section IX details the intervention and equipment used by the EMT either at the scene or en route to the hospital. These include treatments for heart, lung and airway problems; equipment used to lift and move the patient; position of the patient during transport; splinting equipment and techniques; dressings, etc.

Section X is for the identifier code of the emergency vehicle (license plate number) and the attendant; physician, if any, under whose orders they were acting; and the name of any other person (female escort, hospital personnel, etc.) who may have been involved in the incident.

Section XI contains information on the nature and conditions of the run as well as the EMT's determination of run priority.

Section XII is a space for any miscellaneous comments and the patient's signature.

The first page of the three part form is the research copy which is back-printed to accept the hospital report. This is completed in the hospital emergency room and returned to the project office for processing.

The second page of the form (ambulance service copy) is identical to the first page on the front print. Back-printed on the second page is an "ambulance billing form". This page, retained by the ambulance provider, contains further information to aid the commercial purveyors in rendering their charges. The top portion of the sheet allows space to reproduce the patient's name, address, etc. The sheet then goes on to catalog further billing information including a responsible party, attorney, insurance company, etc. This area also provides space to record medicare, welfare, and/or insurance policy numbers. There is an area to include information required by the Department of Welfare of the State of Connecticut for payment by that agency (physician's name, and state license number and the assigned provider code). The lower section of the form is a ledger developed by the printer's representative working with the project staff. The standard business form was adapted to the needs of the ambulance companies and allows for the recording of charges, billing dates, and payments. The bottom of the form is printed with a window for an address which would appear in a standard business envelope.

The third page of the form (hospital copy) is identical to the first two and is designated to provide the physician in the emergency room with documentation of the prehospital conditions and treatments and was to be included in the hospital medical record.

Homoform. As one method of data validation, a "homoform" was developed for use by the interviewer stationed in the hospital emergency departments. This form provided a quick reference of treatments provided, should the ambulance crew be called out on another assignment before the data collection sheet is completed. Secondly, it allows the interviewer to record "visible treatments" as the patient enters the E.S. This data is used to validate the EMT-recorded treatments on the ambulance run report form.

The homoform is composed of an outline drawing of an individual which can represent an anterior or posterior view. The face is drawn in some detail and there are some basic topographical anatomy landmarks. Surrounding the figure are reproductions of the treatment section of the evaluation form. The appropriate boxes may be checked and lines drawn to indicate the area where that particular treatment was applied. The bottom of the form contains an area of any remarks as well as a mechanism to cross-index the homoform and the encounter form and identify the ambulance serivce.

A "training manual" (see appendix) was developed to explain the evaluation form to all those who would be using it: ambulance and rescue personnel, project staff, hospital emergency room personnel, etc. It provides a brief background on the scope and method of the study, a description of the evaluation form, and an explanation of all terms used on the form. In the appendix of the manual are a series of hypothetical situations to provide a review of the use of the evaluation form. Three scenarios are provided in detail, accompanied by appropriately completed forms.

The core staff developed a presentation explaining the evaluation project using slides and tape recordings. From many conversations with the various agencies interfacing with the project came the conclusion that a unified preimplementation presentation of both the project and data collection process was essential. To this end, a series of 35 mm. slides explaining the history, purpose, and scope of the evaluation effort was produced.

A list of the diagnoses (clinical impressions) most frequently encountered in the previous Yale Trauma Program Study was printed along with their ICDA code numbers. Each of the form packs used by the individual EMTs had a laminated list of the diagnoses and code numbers attached. It was anticipated that the EMT would be sufficiently well versed in the use of this short list and the code numbers to do the coding himself once the interviewers were phased out.

Data Collection and Processing. Data was collected over a 4-month period from June 16 to November 1, 1975, using interviewers. The interviewers were stationed in the emergency departments of the two hospitals in New Haven: Yale-New Haven Hospital and the Hospital of St. Raphael. Twenty-four hour staff coverage was maintained throughout the study at Yale-New Haven Emergency Room and sixteen hour coverage at St. Raphael's Emergency Room. After preliminary interviewing it was found that the number of ambulance visits during the 12:00 a.m.–8:00 a.m. shift at the Hospital of St. Raphael did not warrant the presence of an interviewer. In addition, data was also collected from Milford Hospital. An interviewer was stationed in the Milford Hospital for a period of two weeks by which time the data collection system became self-sufficient; that is, the EMTs completed the encounter form without aid of an interviewer.

The instruments used to collect data were the encounter form and the homoform previously described. The interviewers were instructed to locate themselves such that they would be able to observe the arrival of all ambulance cases. The interviewer waited until the patient was discharged by the EMT and any duties, such as obtaining billing information, were completed before approaching the EMT. An average of three to five minutes was needed to complete each interview. Any additional information needed, such as M.D. diagnosis, was obtained from hospital sources. Quality controllers were used to ensure the accuracy of all data. Each day the quality controllers would review all cases collected for any discrepancies between the form and the hospital record. Any inaccuracies discovered were corrected by consultation with interviewers, EMTs and hospital personnel.

Self-Assessment. While the use of interviewers for collecting data lent immeasurably to the quality of data obtained, the logistical obstacles to this method for long-term data-collection and evaluation are obvious. The benefits of using observers, when compared to the cost, are defensible only for the period of time it takes the EMTs to become familiar with the data collection instrument. Also, the presence of this individual in an already crowded E.S. was something of a concern during the data collection period.

If there is to be developed an ongoing quality control system for prehospital emergency medical services providing continuous feedback for evaluation of performance and, secondarily, quality of training, there must be created a motivation for an uninterrupted data base. These motivational factors were built into the New Haven study at different points.

A good deal of input was solicited from the providers as the encounter form evolved from the original Yale Trauma Program instrument. The staff made every effort to avoid creating a record perfectly suited for research purposes, but unsuited for on-going data collection in the field. The crucial consideration was to produce a system of data collection which would not alienate the emergency medical technicians who were actually providing those services being evaluated.

A second area which the project staff developed as an inducement for cooperation was the Ambulance Billing Form backprinted on that copy of the second (yellow) sheet to be retained by the prehospital provider. Again, the operators were polled for input on those types of information collected for business reasons. All of these data were incorporated on this page along with an area for posting debits and credits. While this concept was embraced readily by the ambulance companies, they were naturally reluctant to adopt a totally new bookkeeping system whose longevity was uncertain. It would have been unrealistic for these businessmen to alter their billing and bookkeeping methods for the four-and-a-half months which were available for the study. The form was used satisfactorily by the Chamberlain Ambulance Service in Milford to capture the information which they felt necessary and is still being used by them for data collection and billing purposes.

Beyond these logistical motivations, however, lay the most important concern: improvement of field performance based on continuous data and evaluative feedback. A frequently-voiced complaint of EMTs is their inability to determine case outcome and, hence, determine whether their intervention was correct and/or beneficial. In the New Haven hospitals, the ambulance personnel rarely share in the physician's evaluation of cases brought to the emergency department. As a consequence, they derive little satisfaction from their work and are not able to appreciate any degree of error or inappropriateness in their actions.

Self-administration of the data from was the only technique utilized in Milford (following the presence of a part-time interviewer during a break-in period), a setting which is significantly less chaotic than the larger hospitals. The manager of the Milford ambulance (Chamberlain) was exceptionally supportive of the effort as was Dr. Alan Brandt, the Director of the Milford Hospital Emergency Department, a member of the project's advisory council. It was subjectively felt that the Milford EMTs were more receptive to providing information because they were familiar with the concept of an informal case review following a particularly interesting difficult incident. Had the project been able to evolve to the point where ongoing educational seminars were organized for the New Haven group, it seemed probable that the majority of EMTs would have embraced self-assessment voluntarily.

Results

Data was collected on all ambulance cases transported to the Emergency Service (E.S.) of three hospitals, Yale-New Haven Hospital (YNHH), Hospital of St. Raphael (HSR), and Milford Hospital (MH), between June 16, 1975 and November 1, 1975. Observers were present in the E.S. of YNHH 24 hours per day during the entire test period to spot validate data (Appendix A), verify physician's diagnosis and patient disposition, and to assist the EMTs in completing the data collection instrument (Appendix B). Observers were present in the HSR E.S. 24 hours per day for the first two weeks, then only on day and evening shifts thereafter. The caseload on the night shift (1 to 2 per 8 hours) did not warrant expending an entire observer shift for collection. Most cases (85%) arriving on the night shift at HSR had data collection forms completed voluntarily by the EMTs, and physician diagnosis and patient disposition were verified the following day. Observers at Milford Hospital worked with the senior project staff to train the E.S. staff and EMTs to complete the data collection instruments. The training and observation period at MH extended for 2 weeks following which hospital personnel supervised EMT data collection. Validation of physician diagnosis and patient disposition at MH was done from the E.S. records on a weekly basis by project staff.

Capture rates of data on ambulance cases varied slightly between hospitals, being best at YNHH (96%), and less complete at the HSR (90%) and MH (88%). Observers on location at all times (YNHH) resulted in a lower number of missed cases when the actual cases collected were compared with the official hospital log of ambulance arrivals. Use of the "voluntary" reporting system (MH) was relatively effective, however, with the assistance of hospital staff to encourage data instrument completion.

Validation of Data

A total of 541 cases were validated with the homoform at YNHH and HSR (see Appendix A). Using this form the observers could varify the presence of "visible signs of treatment" such as ongoing CPR, presence of a dressing or splint, administration of oxygen, and positioning of the patient. There were 1057 separate treatments recorded on the 541 homoforms. These were compared with the corresponding data collection forms to validate EMT recorded data. There were 42 (4%) discrepancies between the observer recorded homoform data and EMT evaluation form data. Of these, 31 (2.9%) were data items recorded by the observer, but not recorded by the EMT (EMT underrecording of treatments), and 11 (1.1%) were data items recorded by the EMT, but not validated by the observer. It could not be determined whether these were treatments actually provided, but not noted by the observers, or whether these represented "overrecording" or misrepresentation by the EMT. Of these 11 treatments, 5 were EMT recorded dressings with no treatment noted by the observer, and 6 were EMT recorded splints with a "dressing" noted by the observer. The latter group appear to represent a difference in interpretation of the observation rather than misrepresentation of data. The former group (5) may be misrepresentation, but more likely represent an error or omission in observation, since each patient had indications for a dressing. There were also 73 (6.9%) descrepancies between observer and EMT recorded data concerning patient position. In most instances the observer indicated a specific position (sit, head up, supine, etc.) while the EMT indicated "position of comfort." Whether a position was "of comfort" or not could not be validated, and the usefulness of position as a mandated treatment is felt to be diminished except where a precise position can be required.

Based on the subset of validated cases, the overall validity of treatment data actually recorded by EMTs is felt to approximate 99%, but there is at least 3% underrecording of "visible" treatments. It was impossible to validate other EMT data such as signs and symptoms and EMT treatments not necessarily visible at the time of arrival in the E.S. (e.g. airway clear, jaw pull, straighten fracture, reassurance, etc.). As a consequence, the absolute validity of all EMT data cannot be determined. The validity of EMT data-recording in the absence of observers (i.e. self-recording) could not be established, but this data appeared consistent with observer-validated data.

Case Mix

A total of 4,851 cases was surveyed using the EMT data collection instrument. The partitioning of cases between hospitals was approximately: YNHH 65%, Hospital of St. Raphel 30%, and Milford Hospital 5%. There were 701 cases (14% of all surveyed) which had incomplete data, most frequently physician diagnosis and less often EMT diagnosis. Data was sufficiently complete on 4,150 (86%) to permit an initial analysis. Of this group, 2233(54%) had one or more diagnoses with a mandated treatment for a total of 2401 separate diagnostic cases (7% multiple diagnosis rate). Those cases with no mandated treatments included contusions, sprains and strains, abdominal pain, "to be checked" (usually following a motor vehicle accident), and the like. The mix of cases by physician diagnosis is presented in Table II. Of the cases analyzed, there were 54% males and 46% females with a relatively even distribution by age. Whites (66%) outnumbered nonwhites (34%), but non-whites represented a larger proportion of the total group than in the local population base. Of the cases which were surveyed for accuracy of EMT diagnosis, (2957), 41% represented some form of trauma, and 59% were considered medical problems. Approximately half (46%) of trauma cases were related to vehicular accidents.

Of the total of 1227 trauma diagnoses, 1160 had mandated treatments and could be analyzed for both diagnostic and treatment factors.

There were 1730 medical diagnoses, of which 45% (783) were considered acute or urgent and were related primarily to heart, lung and airway conditions. This group constituted 19% of all cases surveyed and 33% of all cases with mandated treatments. An additional 32% (947) of cases surveyed for diagnostic accuracy (2957) constituted miscellaneous medical problems including psychiatric disorders, upper respiratory infections, intoxication, and other non-acute conditions. While medical conditions constituted 59% (1730) of the cases surveyed for diagnostic accuracy, only 1241 (42%) had mandated treatments and could be analyzed for both diagnostic and treatment factors.

Of the total group of cases with mandated treatments (2401), 48% (1160) were trauma cases and 52% (1241) were medical cases. Approximately 9% of all cases surveyed were diagnosed as either acute or chronic alcohol abuse (7.5%) or psychiatric disorder (2.7%), and 3% of the total surveyed had no observable disease or injury at all.

The diagnostic acumen of EMTs varied widely among diagnostic groups. For trauma conditions it was high (i.e. ≥ 80%) for lacerations, amputated digits, puncture wounds, second degree burns and fractures of the wrist. For medical conditions, it was highest for cardiac arrest, smoke inhalation, and foreign body in airway. The diagnostic acumen tended to be low (less than 50%) among trauma cases for fractures of the thoracic/lumbar spine, pelvis, humerus, ulna/radius, femur, knee/patella, skull and mandible. It was also low for amputated facial parts, abrasions, and avulsions, but the majority of these conditions were diagnosed by the EMT as "laceration" and the apparently low diagnostic accuracy is for this reason somewhat artifactual. Diagnostic accuracy for acute or major medical conditions was low for respiratory arrest, angina, arrhythmias, pulmonary edema, emphysema, pneumonia, and pneumothorax. For miscellaneous medical conditions it was low for hyperventilation syndrome, infectious/inflammatory abdominal disease, upper respiratory illness, suicide gestures, and lower gastrointestinal bleeding.

Tables III–VI summarize the diagnostic accuracy (for true positives) for groups of conditions. It may be seen that the overall diagnostic accuracy for true positives is high for open soft tissue injuries (81%) when abrasions are excluded. Burns and upper extremity dislocations are also diagnosed with a high degree of accuracy (78% and 79% respectively), in contrast to dislocations of the lower extremity (43%) and fractures of the spine and pelvis (22%). The overall diagnostic accuracy for all true positive heart, lung and airway conditions is 57%, but declines to 52% when only the serious and/or potentially life-threatening conditions such as a cardiac arrest, myocardial infarctions, etc. are surveyed. The diagnostic accuracy for miscellaneous medical problems is comparable (48%). It is notable that the diagnostic accuracy for fractures is lowest for spine and pelvic injuries, higher for upper extremity injuries, and highest for lower extremity fractures. Conversely, the diagnostic accuracy of dislocations is highest for upper extremity conditions and substantially lower for lower extremity conditions.

While it is academically satisfying to have a high degree of diagnostic accuracy in all areas, this has specific and mandated therapeutic value in only a few select situations. Satisfactory EMT performance is not necessarily dependent upon accurate diagnosis, but frequently involves the treatment of signs and symptoms. A more accurate assessment of the EMT's performance is obtained by examining his rate of appropriate treatment (Y'), represented by the sum of appropriate treatments (A+C) divided by the total number of true positive cases (N). Among trauma cases, appropriate treatment rates (Y') (≥ 80%) for fractures of the cervical, thoracic and lumbar spine and femur, as well as third degree burns. It is low (<50%) for fractures of the clavicle, humerus, ulna/radius, wrist, knee/patella, tibia/fibula, and foot/toes, and for abrasions. Among medical conditions, Y′ is high for cardiac arrest, pulmonary edema, and smoke inhalation, while it is low for arrhythmias, pneumonia, pneumothorax, stroke, seizure, and foreign body in the airway. Of note is that the rate of appropriate treatment (Y′) is exceedingly low for hyperventilation syndrome (4%).

Referring to Tables III–VI, it is apparent that treatment rates do not parallel diagnostic rates. For example, while diagnostic accuracy for fractures was exceedingly low for spine and pelvic injuries (22%), treatment appropriateness was higher for this group (70%) than for fractures of either upper or lower extremities (28% and 54% respectively). Dislocations of the upper extremity were diagnosed 79% of the time in contrast to lower extremity (43%), but treatment appropriateness was lower for upper extremity dislocations (42%) than for lower extremity dislocations (57%).

The rate of appropriate treatment for all "heart, lung and airway" conditions was 48%, but for serious or life-threatening conditions within that group was 65%. The reverse pattern is seen when examining diagnostic accuracy, in that the overall accuracy for all heart, lung and airway problems is higher (57%) than the accuracy of diagnosis within the subset of life-threatening conditions (52%).

The basic data for all diagnostic groups are tabulated in the summary Tables VII(A)–X(A). Diagnostic factors for each diagnosis are summarized in Tables VII(B)–X(B), and all treatment factors in Tables VII(C)–X(C). Tables VII(D)–X(D) display a comparison of diagnostic and treatment factors. The implications of the findings within each of the tables will be discussed subsequently.

Discussion of Diagnostic/Treatment Results

Trauma: There is a wide variation in the diagnostic accuracy and treatment consistency within trauma cases. Although diagnostic accuracy is frequently low for conditions with a high risk of increased morbidity or mortality in the absence of proper treatment (such as fractures of the spine, pelvis, hip and femur), the rate of provision of appropriate treatments tends to be high. Overdiagnosis is frequent, as is underdiagnosis, but overtreatment occurs more often than undertreatment. For conditions with a lower risk of increased morbidity or mortality in the absence of proper treatment (such as fractures of the clavicle, humerus, wrist, hand/finger, and foot/toes), the reverse pattern is seen: diagnostic accuracy tends to be somewhat better, but the rate of appropriate treatment tends to be lower. Under-diagnosis is not as common as overdiagnosis, but undertreatment occurs more frequently than overtreatment.

Spine/Pelvis Fractures: There were 16 cases of fractures of the spine (cervical, thoracic, lumbar) and sacrum/coccyx and 11 cases of fractures of the pelvis. Mandated treatments for each of these includes use of a backboard or scoop stretcher. Of a total of 27 cases, only 6 (22%) were correctly diagnosed, but 19 (70%) were correctly treated. The diagnostic accuracy is poor, ranging from 0% for fractures of the sacrum/coccyx to 38% for fractures of the pelvis. Underdiagnosis was high for pelvis (73%), thoracic/lumbar spine (91%) and sacrum/coccyx (100%). One case of cervical spine fracture was not diagnosed out of three 33%). Overdiagnosis was high for cervical spine (89%), thoracic/lumbar spine (90%), pelvis (63%). No cases of fracture of the sacrum/coccyx were diagnosed by the EMT, although the physicians diagnosed 2 cases. One must conclude that the diagnosis of fracture of the sacrum/coccyx is probably difficult to separate from fracture of either the lumbar spine or pelvis. Since the treatment is the same for all three conditions, it is unrewarding to evaluate this diagnostic group separately from the other two. The high rate of overdiagnosis for fractures of the cervical spine, thoracic/lumbar spine, and pelvis indicate the perceived, and real, severity of the conditions. The high rates of underdiagnosis suggest the difficulty in making an accurate diagnosis of these conditions in the field.

Of more concern to the trainer, evaluator, and consumer is the rate of appropriate treatment. When the EMT diagnoses one of these conditions, his rate of appropriate treatment is 78%, while for those cases the physician diagnoses the rate of appropriate treatment is 70%. When the EMT and physician agree (A+B), the rate of appropriate treatment is 67% (4 of 6 cases). Of the 27 cases total, 56% were treated on the basis of signs and symptoms (total of all C cell cases), the EMT having not made the diagnosis. Overtreatment is most common for supposed cervical spine fractures (70%) and less for supposed pelvis (40%) and thoracic/lumbar spine (36%) fractures. Undertreatment was low for spinal fractures (cervical—0%, thoracic/lumbar—18%) and higher for pelvis (45%) and sacrum/coccyx (50%). The probability that the EMT will make the correct diagnosis, yet fail to treat one of the 4 conditions, is low, as is the probability that he will make the correct diagnosis at all. The probability, therefore, that his correct treatment is based on a correct diagnosis is also low, with the exception of cervical spine fractures, where this probability equals 0.67. One must conclude that the EMT bases the major portion of his treatments on signs and symptoms which suggest the presence of an injury and does not base his treatments on first making a correct diagnosis. He also tends to treat whenever he elicits these signs and symptoms, even though the supposed injury may not be present.

It is revealing to examine the rate of appropriate treatment the EMT provides for cases which he believes to have the diagnosed condition, but where the physician does not make the same diagnosis. One must assume that some signs and symptoms suggesting the supposed diagnosis are present (such as neck pain, pelvic tenderness, etc.) but that they may not be as pronounced for this group of cases as those which actually have the injury present. The factor Y''' represents the rate of appropriate treatment for such cases ($C_E/C_E + D_E$). The rates of treatment (Y''') for *supposed* cervical or thoracic/lumbar spine fracture are similar (47 and 56% respectively) and for supposed fracture of the pelvis is 83%. These are also quite comparable to the overall treatment consistency rates (Y) for each of these problems. The overall rate of treatment for cases the physician diagnoses (Y'') is higher for fractures of the cervical and thoracic/lumbar spine and sacrum/coccyx (100%, 82%, and 50% respectively). Comparing these figures with the treatment rates for cases where the EMT and physician agree on the diagnosis (Y''), one sees that the rate of treatment for cervical spine fracture remains 100%, but for thoracic/lumbar spine and sacrum/coccyx fracture the rate is 0%. Physician-diagnosed pelvic fractures are treated 54% of the time, but when the physician and EMT agree in their diagnosis (Y'' or cells A + B), the treatment rate is 67%. This is close to the overall consistency of treatment for EMT-diagnosed cases (75%), and lower than the treatment rate for cases diagnosed by the EMT which were, in fact, not pelvic fractures (83%). This data further suggest that treatment on the basis of signs and symptoms is important for this group of diagnoses. While it is true that if the EMT makes one of these diagnoses he will most likely treat the case, it is not likely that he will make the correct diagnosis. Making the "correct" diagnosis is probably not an important determinant in the decision to treat or not, but the presence of suggestive signs and symptoms result in most true positive cases receiving the approprate interventions.

Upper Extremity Fractures: There were a total of 88 upper extremity fractures (clavicle, humerus, elbow, ulna/radius, wrist, and hand/finger), 47 (53%) of which were correctly diagnosed and 25 (28%) of which were appropriately treated. Diagnostic accuracy ranged from 33% correct for fractures of the humerus, to 39% correct for fractures of the wrist. The rate of appropriate treatment was substantially lower than would be anticipated based on the incidence of correct diagnoses. Appropriate treatment ranged from 0% for hand/finger fractures and 21% for humerus fractures to 34% for clavicle, 38% for wrist, and 42% for ulna/radius. There were two elbow fractures, one of which was treated appropriately. Underdiagnosis is frequent, except for fractures of the wrist where it is only 8%. Overdiagnosis occurs at a higher rate for all groups than does underdiagnosis.

Treatment rates present the opposite picture, with undertreatment occurring with a higher frequency than overtreatment in all but one diagnostic group (ulna/radius). The overall treatment consistency (Y) is low, and does not differ appreciably between the subset of cases where the physician diagnoses the condition (Y') or that in which the EMT diagnoses the condition (Y). For the subset of cases which the EMT diagnoses incorrectly (i.e. overdiagnosis), the rate of appropriate treatment (Y''') still remains similar to Y and Y'. The probability that an EMT will correctly diagnose the condition and yet fail to treat it appropriately is high, ranging from 0.4 for ulna/radius to 1.0 for elbow and hand/finger. Five of the six upper extremity fracture groups have a probability of $Dx+/Rx-$ greater than 0.6. When an appropriate treatment is provided by an EMT, the probability that it is based upon his making the correct diagnosis is also relatively high, ranging from 0.5 for clavicle, and 0.6 for ulna/radius, to 0.8 for humerus and wrist. This suggests that when an appropriate treatment is provided, it is usually associated with a correct diagnosis, but that making the correct diagnosis does not imply that the correct treatment will be provided. In fact, having made the correct diagnosis there is still only a 50-50 chance that the EMT will provide the approprate treatment. As would be expected, this is associated with a relatively high rate of undertreatment and relatively low rate of overtreatment.

Fractures of the upper extremity are usually associated with easily discerned signs and symptoms, yet the correct specific diagnosis is not made as frequently as one would expect, with the exception of fractures of the wrist (93%). Fractures of the upper extremity, however, are not life-threatening and are probably not viewed as "serious" when compared to such fractures as cervical spine and pelvis. Since the rate of treatment for those cases correctly diagnosed remains low, one must conclude that even for this subset, the signs and symptoms were not sufficiently severe to prompt the EMT to treat the condition. Clearly, making the correct diagnosis is not a central determinant in the provision of appropriate treatment. One can only assume that appropriate treatments, when provided, are done so on the basis of obvious signs and symptoms such as severe pain, or gross angulation or deformity. Whenever a correct diagnosis is made of a spine or pelvic fracture, the probability that the correct treatment will be provided is exceedingly high. Upper extremity fractures present a very different pattern of care, in that even having made the correct diagnosis, the probability is substantial that the appropriate treatment will not be provided. In this case, it is not the mere presence of signs or symptoms which prompts the appropriate treatment, but more likely the severity of presentation which is the critical determinant.

Lower Extremity Fractures: A total of 138 cases with fractures of the lower extremity were surveyed. Of these, 76 (55%) were correctly diagnosed and 74 (54%) were correctly treated. The rate of correct diagnosis ranged from 0 for knee/patella to 71% for hip fractures. Treatment rates ranged from 20% for foot/toe to 67% for hip fractures. The overall diagnostic accuracy (x) ranged from 0 for knee/patella to 57% for hip fractures, and all but the latter group were equal to or less than 45%. Underdiagnosis was least frequent for hip fractures (29%) and most common for fractures of the knee/patella where no cases were diagnosed correctly. Overdiagnosis is also common for knee/patella fractures (100%) and next for femur (75%) and ankle (77%). Overdiagnosis tended to be slightly more common than underdiagnosis. EMT treatment rates tended to be similar for EMT-diagnosed cases (EDx), physician-diagnosed cases (N), and those cases where the EMT and physician agreed (A+B). An exception to this was knee/patella, where the EMT treatment consistency rate (Y) was 64%, but Y′ was 46% and Y″ was 0%. Overtreatment was most common for fractures of the ankle (74%) and foot/toes (67%) and was least frequent for fractures of the hip (30%). Undertreatment was highest for fractures of the foot/toes (80%) and lowest for fractures of the femur (15%) and hip (33%). The rate of treatment for all cases diagnosed by the EMT (Y) is very similar to the rate of treatment for those cases the EMT diagnoses but which actually do not have the diagnosed condition (Y″′). In examining those cases where the EMT and physician agree on the diagnosis (Y′) (i.e. where the signs and symptoms are perhaps more definitive), the treatment rates are seen to be higher for fractures of the hip and femur, while lower for the remaining diagnoses.

Having made the correct diagnosis, the probability that the EMT will fail to provide the appropriate treatment is quite low for fractures of the femur (.11), hip (.26), and ankle (.27), but is substantially higher for fractures of the tibia/fibula (.56) and foot/toes (.67). The probability that the appropriate treatment provided is based upon having made the correct diagnosis is highest for fractures of the foot/toes, (1.0), ankle (.8) and hip (.79) and is substantially lower for fractures of the tibia/fibula, femur, and knee/patella. It would appear that making the correct diagnosis is an important determinant in the provision of appropriate treatment for fractures of the hip and femur, but is a less significant factor for other lower extremity fractures. The diagnostic accuracy for femur fractures is less than for fractures of more distal bones, yet this group has the highest rate of appropriate treatment. For this group, making the correct diagnosis would appear important, but the presence of signs and symptoms must also play an important role. For more distal fractures, it would appear that it is the severity of signs and symptoms, rather than their mere presence, that is the critical determinant, since merely making the diagnosis does not ensure that the appropriate treatment will be provided. However, when the appropriate treatment is provided, it is most often associated with the EMT having made the correct diagnosis.

Fractures of the hip and femur have the highest rate of appropriate treatment, and both require use of a Thomas Splint. It is notable that applying a Thomas or traction splint appropriately requires considerable practice and skill. Its use is stressed in lectures and practical sessions, and most EMTs take great pride in their skill in using this splint. Several varieties of splints are appropriate for more distal fractures, such as air splints, and although splinting here should be easier, the appropriate treatment rates are lower. The apparent or presumed seriousness of a proximal fracture (femur or hip) is greater than that of a distal fracture, and this may be an important element in the EMT decision-making process. This same pattern of relatively low diagnostic accuracy, yet high treatment appropriateness for "serious" fractures is seen in spine and pelvis cases. Distal lower extremity fractures are less "serious" and resemble upper extremity fractures in treatment rates.

Skull/Facial Bone Fractures: There are no mandated treatments for fractures of the skull, facial bones, or mandible, but an evaluation of the diagnostic acumen of the EMT for those conditions may be conducted. There were a total of 57 such fractures diagnosed by the physician. The EMT was most accurate in diagnosing facial bone fractures (53%) and least accurate in diagnosing skull fractures (35%). Underdiagnosis was most common among skull fractures (65%) and least common for facial bone fractures (56%), while overdiagnosis was also most common for skull fractures (53%) and least common for fractures of the mandible (25%). The selectivity of the EMT tended to be low for skull (35%) and (43%) mandible fractures, indicating a relatively high false negative rate. The specificity of diagnosis tends to be higher (60%) for facial bones and for mandible (75%) indicating a relatively low false positive rate.

While there are no specific treatments indicated for those diagnostic groups, awareness of the diagnosis on the part of the EMT may affect his treatment in specific circumstances. Given the relatively low level of diagnostic accuracy, it is unlikely that there is any specific benefit to having the EMT make an appropriate diagnosis. He would be expected, therefore, to treat any associated conditions (airway obstruction, unconsciousness, etc.) on the basis of signs and symptoms alone. Establishing the correct diagnosis may become critical in certain circumstances however, such as during the triage phase of a multiple casualty accident. In this situation it would be critical that the EMT be able to identify those patients with high risk injuries such as skull fractures for early transportation. Given these data, he does not appear to be able to function effectively in triaging such patients.

Upper Extremity Dislocations: A total of 19 dislocations was encountered, 15 occurring in the shoulder. The number of elbow and wrist dislocations was too small to evaluate, although all calculations are presented. The rate of correct diagnoses of shoulder dislocations was 73%, and the rate of appropriate treatment was 27%. All elbow dislocations (3) were correctly diagnosed and treated, and the single wrist dislocation was incorrectly diagnosed, but appropriately treated. Although the diagnostic accuracy for shoulder dislocations was good (73%), 8 of the 11 cases correctly diagnosed were not treated (73%). The treatment and consistency rate for all EMT diagnosed cases (Y) was low (17%), while the rate of treatment of cases diagnosed by the physician (Y′) was somewhat higher (27%). Of those cases where the EMT and physician agreed on the diagnosis (Y″), 27% were also treated appropriately. Of interest is that, of those cases the EMT diagnosed as shoulder dislocations, but which, in fact, did not have the condition (Y″), the rate of appropriate treatment was only 8%. The probability is high (0.75) that when the EMT provides the appropriate treatment it is associated with his having made the correct diagnosis. Making the correct diagnosis, however, does not ensure that the appropriate treatment will be provided. Quite the contrary, the probability that given the correct diagnosis, the appropriate treatment will not be provided is 0.73. Clearly, making the correct diagnosis does not provide sufficient impetus for the EMT to treat this condition. The signs and symptoms of a shoulder dislocation are usually minimal deformity, and pain which may be minimal or only moderate. One must conclude that it is the severity, rather than mere presence, of signs and symptoms which is the important determinant and that making the correct diagnosis probably is only of secondary importance.

Lower Extremity Dislocations: A total of 7 lower extremity dislocations (hip, knee/patella, ankle) were seen. The numbers within each diagnostic group are too small to evaluate with significance. One can only state that 3 of 7 (43%) dislocations were correctly diagnosed and 57% were appropriately treated. Two cases were correctly diagnosed and treated, 2 cases where correctly treated on the basis of signs and symptoms in the absence of the correct diagnosis, and one case was diagnosed correctly (dislocated knee/patella) but was not treated.

Open Soft Tissue Injuries

A total of 844 open soft tissue injuries (lacerations, avulsions, abrasions, puncture wounds, etc.) were encountered. A total of 573 (68%) were diagnosed correctly and 458 (54%) were treated appropriately. The apparent diagnostic accuracy of the EMT is somewhat affected by semantics in that a deep or severe abrasion may be termed a laceration by the EMT, yet called an abrasion by the physician. The reverse is also possible. A wound caused by a penetrating object, but producing a small laceration of the skin may be termed either a puncture wound or a laceration. The accuracy of diagnoses for open soft tissue injuries is of less significance than for other conditions, since all open soft tissue wounds require the same treatment (i.e. appropriate dressing). Diagnostic accuracy is seen to range from 0 (avulsions) to 100% (amputated digits). The two major groups, lacerations and abrasions, have accuracy rates of 83% and 36% respectively.

The rate of appropriate treatment varies less widely, being highest for lacerations (61%), amputated digits (60%), puncture wounds (59%), and avulsions (58%), and lowest for abrasions (39%). If abrasions are removed from the total group of open soft tissue wounds, to leave a group of conditions all of which clearly require a dressing, and clinically appear as lacerations (with the possible exception of puncture wounds and some animal bites), the incidence of appropriate treatment rises to 60% (from 54% overall).

The incidence of underdiagnosis is highest for avulsions (100%); all of these were diagnosed as lacerations. Underdiagnosis of abrasions (64%) and amputated facial parts (58%) is accounted for by the EMT diagnosing the majority of these again as lacerations, although some abrasions were not diagnosed at all by the EMT. Overdiagnosis tends to be low, and again is accounted for primarily by differences in nomenclature between the EMT and physician for the same visible injury. Treatment rates for cases diagnosed by the physician (Y′) range between 50% and 61% for all groups with the exception of abrasions (39%). These rates were essentially unchanged for the subset of cases where the EMT and physician agreed on the diagnosis (Y"). Undertreatment of cases ranged from 39% for lacerations to 61% for abrasions. The statistics for overtreatment by individual diagnosis are misleading in that a dressing applied for any open wound would be appropriate; given the wrong diagnosis, however, the treatment would be listed as "overtreatment" (i.e. treating something which was not there). The subset of cases diagnosed by the EMT as having a specific condition, but where the physician did not agree (Y" '), nonetheless had essentially the same rate of treatment as all cases diagnosed by the EMT (Y) and those cases where the EMT and physician agreed (Y" '). The only exception to this was the diagnostic group of avulsions.

The probability that an EMT will correctly diagnose an open soft tissue wound, yet fail to provide the appropriate treatment is 0.36 for lacerations, 0.35 for puncture wounds, and 0.53 for abrasions. The probability that an appropriate treatment is based on the EMT making the correct diagnosis is high for lacerations (0.87) but low for abrasions (0.43). For open soft tissue wounds, it does not appear that making the correct diagnosis is a central element in the provision of the appropriate treatment. Numerous cases correctly diagnosed are not appropriately treated, and the converse is also true. While there may be other factors operational, it would appear that some of the differences between the number of cases diagnosed and the number treated could be explained on the basis of the severity of the injury. The location of the injury may also play a role. For example, abrasions or small lacerations of the face or fingers would be relatively difficult to dress and have a lower rate of appropriate treatment than those on the trunk and more proximal extremities. That the severity of signs and symptoms of the injury is important may be seen by the low rate of appropriate treatment for such conditions as animal bites (usually multiple puncture wounds) and abrasions. Those injuries actually diagnosed as puncture wounds, on closer examination, were frequently stab wounds or penetrating wounds caused by broken glass or metal, and not puncture wounds in the more common sense of a needle, nail or other minor injury. The treatment rates here are consequently quite similar to those for lacerations.

Burns. A total of 27 burns were studied, including one chemical, 10 first degree, 12 second degree, and 4 third degree. The single chemical burn was correctly diagnosed and appropriately treated. There is no mandated treatment for first degree burns, although diagnostic accuracy was 78%.

Diagnostic accuracy for second degree and third degree burns was high (92% and 67% respectively). Underdiagnosis and overdiagnosis was low (8%) for second degree burns and somewhat higher (50% and 30% respectively) for third degree burns. The rate of appropriate treatment was 100% for third degree burns and 75% for second degree burns. The probability that the EMT will make the correct diagnosis yet fail to treat a burn appropriately is exceedingly low (0.18 for second degree, 0.0 for third degree), and the association between the provision of appropriate treatment and his making the correct diagnosis is high (1.0 for second degree, 0.5 for third degree). Treatment of a burn victim by an EMT requires only the use of a burn sheet or dressing; consequently, high rates of appropriate treatment are to be expected. The high levels of diagnostic accuracy are notable and have implications particularly when the EMT is in a triage situation where the depth of burn may become important in determining whether a patient requires transportation or not, and how soon such transportation should be accomplished.

Miscellaneous Trauma. Three conditions grouped under miscellaneous trauma are snake bite, rupture of the liver or spleen, and hemothorax. The numbers of cases in these groups were small (11, 6, and 3 respectively). Of note is that no patient with a snake bite received the mandated treatments of tourniquet, position, and immobilizing dressing or splint. Although none of the snake bites proved to be from poisonous reptiles, such species are indigenous to the locale and have been found even within the city limits.

Of the 6 cases of ruptured liver/spleen, one (17%) was diagnosed correctly, and 4 (67%) received the appropriate treatment.

Medical Cases: Major There were 789 cases encountered among the 14 diagnostic groups termed "major" medical conditions. Of these, 448 (57%) were correctly diagnosed and 376 (48%) were appropriately treated. If one examines only cardiac and respiratory arrest, myocardial infarctions, angina, emphysema, arrhythmia, and pulmonary edema cases as a subset, the statistics change substantially. Within this group there were 399 cases of which only 52% were correctly diagnosed, but 65% were appropriately treated. The per cent of physician diagnosed cases which the EMT also diagnosed (Y") ranged from 18% for pneumothorax, and 23% for angina, to 83% for cardiac arrest, 86% for foreign body in the airway and 100% for smoke inhalation. The diagnostic accuracy (X) of the EMT ranged from a low of 21% for angina, 30% for pulmonary edema, and 33% for respiratory arrest, to 67% for asthma and 72% for cardiac arrest. Underdiagnosis was most frequent for pneumothorax (82%), pneumonia

(78%), respiratory arrest (71%), arrhythmia (70%), and angina (67%), while it was least frequent in smoke inhalation (0%), foreign body in airway (13%), and cardiac arrest (17%). Overdiagnosis was most frequent in angina (79%), pulmonary edema (70%), and respiratory arrest (67%), while it was lowest in cardiac arrest (28%) and asthma (33%). Some conditions are difficult to recognize in the field (e.g. arrhythmia, pneumonia, pneumothorax) without ancillary diagnostic equipment, and diagnostic accuracy would be expected to be low. The field differential diagnosis of angina vs. M.I., pulmonary edema vs. pneumonia and other medical conditions is also difficult, explaining some of the high rates of over- and underdiagnosis. Conditions such as smoke inhalation, cardiac arrest, and respiratory arrest have a more obvious presentation and are therfore, expected to have a higher rate of diagnostic accuracy and low over- and under diagnosis. An apparent exception to this is respiratory arrest, where confusion with cardiac arrest may exist. In addition, respiratory arrest may be caused by transient airway obstruction, drug effects, or head trauma, but be corrected (improved) by the time of arrival at the E.S. The EMT diagnosis of respiratory arrest might not be confirmed by the physician and the case would be recorded as "incorrect diagnosis" and "overdiagnosis" when, in fact, it was neither.

EMT appropriate treatment consistency ranged from 17% for foreign body in airway and seizure, and 20% for stroke to 83% for cardiac arrest, 75% for respiratory arrest, 73% for pulmonary edema, and 71% for myocardial infarction and smoke inhalation. Appropriate treatment rates for cases the physician diagnosed (Y') were similar to the overall EMT treatment rates (Y), although slightly lower for cardiac arrest (81% vs. 83%), respiratory arrest (64% vs. 75%), and myocardial infarction (60% vs. 71%), and higher for smoke inhalation (100% vs. 71%) and pulmonary edema (83% vs. 73%). Those cases in which the EMT and physician agreed (Y'') in general had higher treatment rates than for all cases the physician diagnosed (Y'). For myocardial infarction the treatment rate for the physician diagnosed group (Y') was 60%, but was 68% when the EMT and physician both agreed (Y''). For respiratory arrest, the treatment rate rose to 89% (from 81%) and for pulmonary edema was 90% (as opposed to 83%). Y'' was equal to or greater than Y' for 10 of 14 diagnostic conditions. In two of the remaining 4, the decrease was 2%. This would suggest that the signs and symptoms manifested by the subset of cases in which the EMT and physician agreed (Y'') were more prominent than for those where they failed to agree, or that the cases appeared more "severe" in their presentation.

Overtreatment tended to range between 20% and 45%, while undertreatment tended to be somewhat higher, with 6 of 14 diagnostic groups having undertreatment rates in excess of 50%. An analysis of the rate of appropriate treatment for those cases incorrectly diagnosed by the EMT (Y''') shows 9 of 14 groups having treatment rates less than the overall treatment consistency rate (Y). This would tend to substantiate the interpretation that the severity or prominence of signs and symptoms is an important determinant in the EMT decision to provide specific treatments. The probability of an EMT correctly diagnosing a given condition, yet failing to provide the appropriate treatments ranges from 0 for smoke inhalation, to 0.85 for foreign body in airway, and 0.84 for seizure. The probability that when the correct diagnosis is made an inappropriate treatment will be provided is lower for life-threatening conditions such as cardiac (0.11) and respiratory arrest (0.25), myocardial infarctions (0.32), angina (0.17) (which is difficult to separate from myocardial infarctions), pulmonary edema (0.10), and smoke inhalation (0.0), than for non-life-threatening conditions such as stroke (0.75), and seizure (0.84). Cases diagnosed as foreign body in airway (appropriately diagnosed 86% of the time) also had a high probability of inappropriate treatment (0.85). On closer examination, the majority of these were nonobstructive upper airway foreign bodies, such as a fishbone or tooth pick, and the "mandated treatments" for these cases may not be the most appropriate standard for evaluation. The range of probabilities is much broader that the appropriate treatment provided by an EMT is based on his having made the appropriate diagnosis, being highest for smoke inhalation (1.0), seizure (1.0) and cardiac arrest (0.92), but only 0.18 for pneumonia and arrhythmia.

The diagnostic acumen of EMTs for major medical diagnostic groups is comparable to their acumen for fractures, and less than for open soft tissue injuries. As was seen with fractures, however, the diagnostic groups with a high risk of incurring an increased rate of morbidity or mortality if not appropriately treated (arrest, myocardial infarction, etc.), have a lower rate of correct diagnosis (52%, vs 57% for all major cases), yet have a substantially higher appropriate treatment rate (65% vs. 48%) (Table III). This same pattern was observed among fractures where the diagnostic acumen for spine and pelvic fractures was low (22%) but the appropriate treatment rate was 70%, substantially higher than for either upper or lower extremity fractures. If the EMT is able to make the correct diagnosis for one of the major medical problem groups, there is a high probability that he will treat the case appropriately. His appropriate treatment appears to be based on the appropriate diagnosis in half to two-thirds of cases, the remainder of the cases being treated on the basis of signs and symptoms alone. The pattern of correct diagnosis/inappropriate treatment observed frequently in extremity fractures and soft tissue injuries is far less pronounced for major medical problems, particularly those which are life-threatening. This pattern is seen more frequently among diagnostic groups with a perceived lesser degree of seriousness such as stroke, seizure, foreign body in the airway, and arrhythmias.

Medical Cases: Minor A total of 947 cases grouped as miscellaneous (minor) medical problems were evaluated, 458 of which had specific mandated treatments. The remainder of the cases could be evaluated only for the accuracy of EMT diagnosis. Of the total group of miscellaneous medical problems, the EMT correctly diagnosed 48% of cases diagnosed by the physician. Of those cases where mandated treatments were applicable, only 41% received the appropriate treatment. There were 5 diagnostic groups sufficiently large for statisically significant evaluation: hyperventilation syndrome (N = 152), infectious/inflammatory abdominal condition (N = 97), psychiatric illness (N = 133), upper respiratory infection (N = 49), and suicide gestures (N = 18). Diagnostic accuracy for these five groups varied considerably: suicide gestures—10%, upper respiratory infection—40%, hyperventilation syndrome—40%, psychiatric illness—59%, infectious/inflammatory abdominal condition—62%. Underdiagnosis was greatest for suicide gestures (94%) and lowest for psychiatric illnesses (44%). Overdiagnosis was also greatest for suicide gestures (90%) and lowest for infectious/inflammatory abdominal conditions (38%). The rate of approprate treatment for those cases diagnosed by the physician (Y′) ranged between 56% and 62% for all conditions except hyperventilation syndrome, which was 4%. It should be explained that appropriate treatment for this condition required both reassurance and use of a rebreathing bag (paper bag treatment). While the majority of cases in this group received reassurance (68%), only 4% received the paper bag rebreathing treatment. The probability that when the EMT made the appropriate diagnosis, he would still fail to provide the appropriate treatment for this condition is 0.90. The same probability calculated for suicide gesture was 1.0 and for the remaining 3 conditions ranged between 0.33 and 0.44.

The mandated treatment "reassurance" is required for hyperventilation syndrome, psychiatric illness, upper respiratory infections, and suicide gesture. The rates of provision of this treatment ranged from 56% for suicide gesture to 68% for hyperventilation syndrome. This is a difficult "treatment" to validate, however, and is probably not a valid performance evaluation criteria item. The mandated treatment for infectious/inflammatory abdominal condition is proper positioning of the patient and occurred in 56% of cases.

The five conditions for which there were no specific mandated treatments were insulin shock, drug overdose, alcohol effect (alcoholism), lower G.I. bleed, and upper G.I. bleed. Diagnostic accuracy (X) ranged from 28% for lower G.I. bleeding to 66% for drug overdose cases. Both under and overdiagnosis were common, although both were lowest for drug overdose and highest for lower G.I. bleeding. It should be noted that a mandated treatment for insulin shock should be oral (or I.V.) glucose. In this locale, however, the attendants were not permitted to administer glucose and did not carry it.

Multiple Treatments. Some conditions have multiple mandated treatments (e.g. myocardial infarction, hyperventilation syndrome). Treatment rates presented for these conditions are for all mandated treatments unless otherwise specified in Appendix C. [For example, myocardial infarction has 3 mandated treatments (oxygen, position, reassurance), but treatment rates are calculated on the basis of only 2. Angina has 3, but calculations are for only 1 treatment.] All data are presented in Appendix A to allow calculation of factors for single or multiple mandated treatments. An attempt was made to present data for the most important combination of treatments based on the opinions of the physician reviewers. In an ongoing evaluative system, rates for both individual and total appropriate treatments should be used.

The Enigma of the "B" Cell

A useful and simple analysis of EMT performance data may be accomplished by creating the 2 × 2 matrix (Figure I) to display diagnostic vs. treatment rates. In this matrix, the "A" cell represents those cases both correctly diagnosed and appropriately treated. The "C" cell represents those cases which were correctly treated, but incorrectly diagnosed. Treatment is provided for these cases (C) either on the basis of signs and symptoms, or by the EMT making a diagnosis which is similar to the correct one (e.g. myocardial infarction vs. angina; laceration vs. avulsion; fracture of femur vs. fracture of hip). The "D" cell represents those cases which were incorrectly diagnosed and inappropriately treated. This cell will frequently include cases with minimal severity of presentation, such as a patient with a myocardial infarction who presents with only anxiety or minimal shortness of breath, or a patient with minimal or no trauma who has a non-displaced or hair-line fracture of an extremity bone with little or no pain. It is unrealistic to expect the EMT to diagnose all such cases wtihout the aid of an electrocardiogram and x-rays, both of which the physician has available, and without which the latter would probably not be able to diagnose many of the same cases.

The "B" cell represents the major enigma in EMT performance evaluation. It is these cases which the EMT has been able to correctly diagnose based on the history and signs and symptoms he elicited, yet he still failed to provide the appropriate treatment. If one accepts the argument that the major concern is that the patient receive appropriate *treatment*, then all cases falling within the A and C cells represent proper management. If one also accepts the fact that some cases will be exceedingly difficult, if not impossible, to diagnose in the field, it becomes reasonable to accept a small percentage of cases within the D cell for many diagnostic groups. This is particularly true for those cases with non-obvious injuries or illnesses such as hairline fractures, myocardial infarctions with a diminutive presentation, pneumonia, and mild pulmonary edema. One is left with a group of cases where the presentation is sufficiently clear to make the correct diagnosis, yet for some unknown reason, the EMT does not provide the appropriate treatment.

There are two major hypotheses one can formulate concerning the enigma of the "B" cell. The first is that while the signs and symptoms of the case are sufficiently clear to permit the correct diagnosis to be made, even if it represents only an educated guess, such signs and symptoms are minimal in intensity. The perceived lack of severity of the signs and symptoms, independent of the diagnostic group in which the case falls, does not prompt the EMT to provide the mandated treatment. This is consistent with the findings that the EMT treats most cases on the basis of signs and symptoms, and that making the correct diagnosis alone is not sufficient impetus for the EMT to always provide the appropriate treatment.

A second hypothesis is that other important variables may be operational in determining whether or not an EMT will provide an appropriate treatment. Such variables may be patient, race, age, or sex, socioeconomic status (SES), or the presence of concomitant conditions such as alcoholism, acute intoxication, drug abuse, or psychiatric conditions, all of which carry a certain social "stigma" and may prejudice the EMT against providing appropriate treatment. Additional variables may be the presence of multiple diagnostic conditions requiring treatment (e.g. fractures and lacerations, myocardial infarction and hyperventilation, etc.) where the EMT may elect to treat the more severe and not treat the less severe condition. Training and case experience variables may be important. It is possible that a large portion of "B" cell cases may be accounted for by EMTs who have infrequent case exposures such as volunteers or part-time attendants. In this situation, one would have to postulate that the basic training plus periodic refresher courses allows the EMT to maintain his diagnostic acumen, but the infrequent use of his training results in skill degradation, leaving him feeling unprepared or unskilled in providing a specific treatment, or not remembering the appropriate treatment. The socioeconomic status of the EMT himself may be an important variable. If one postulates that the EMT has a higher SES than the patient, he may tend to provide appropriate treatment to a lower SES patient. If he has a lower SES, he may be unable to "role play" the part of a professional when dealing with a higher SES patient.

An analysis of data for diagnostic groups with a sufficiently large N to allow comparisons of treatment rates stratified by race (white vs. non-white), age (by decades) and sex failed to disclose any differential treatment patterns. Only the trauma cases had a sufficiently high frequency of multiple diagnoses to permit examination of primary vs. secondary diagnosis treatment rates, the most frequent combination being fractures and open soft tissue injuries. In this analysis, only abrasions had a significantly lower treatment rate when occurring as a secondary diagnosis than when occurring as a single diagnosis (31% vs. 39%). The diagnostic rate $\left(\frac{A+B}{N}\right)$ was not significantly different for any combination of trauma diagnoses when compared to their rates as isolated diagnoses.

It should be pointed out that all diagnoses with mandated treatments require that the appropriate treatment be provided in each case and for each diagnosis unless a concomitant life-threatening problem, such as cardiac arrest, occurs. There were 5 multiple trauma cases in which cardiac arrest and multiple fractures and lacerations were present. These cases were evaluated for the provision of CPR only, since it would be contraindicated to treat the lacerations and fractures in a patient in cardiac arrest. With these few exceptions all conditions with a mandated treatment should be treated. The EMT demonstrated essentially the same rate of appropriate treatment for multiple problems as for the same problems occurring individually. The variables of patient and EMT SES, concomitant conditions with a presumed "social stigma", and the question of EMT performance experience or case exposure frequency will be dealt with in a subsequent section.

Of the 58 diagnostic groups with mandated treatments, 49 (85%) had cases in the "B" cell where there were also cases in the "A" cell. It is unrevealing to include those diagnostic groups in which both the A and B cells were 0, and these diagnostic groups (9) are excluded in this analysis. Dividing the remaining 49 diagnostic groups according to the per cent of B cell cases, one finds that 37% (18) of the groups have a B value of 10%

or less. These include fractures of the cervical and thoracic/lumbar spine, pelvis, femur, and elbow, chemical and third degree burns, rupture of the liver/spleen, cardiac and respiratory arrest, angina, pulmonary edema, pneumothorax, smoke inhalation, carbon monoxide poisoning, unconscious status, upper respiratory infections, suicide gestures. An additional 13 diagnostic groups (27%) have a B cell value between 11% and 25%. These include fractures of the ulna/radius, hip, and ankle, amputated facial part, abrasion, second degree burn, myocardial infarction, arrhythmia, emphysema, asthma, penumonia, infectious/inflammatory abdominal condition, psychiatric illnesses. There are 11 diagnostic conditions (22%) with a B cell rate between 25% and 50%. These include fractures of the clavicle, humerus, elbow, tibia/fibula, foot/toes, and knee/patella, lacerations, amputated digit, puncture wound, animal bite and hyperventilation syndrome. There are 7 diagnostic conditions (14%) with a B cell value between 51% and 75%, and include fractures of the wrist and hand/fingers, dislocations of the shoulder, snake bite, stroke, seizure, and foreign body in airway. No diagnostic conditions have a B value higher than 75%.

Examination of B cell values for trauma cases shows that all potentially life-threatening or "serious" fractures, such as spine, pelvis, and femur fall within the lowest B value group. The single possible exception to this is fracture of the hip (B = 18%). While this is a "serious" fracture, it is rarely life-threatening. Four of six lower extremity diagnostic groups fell within the two lowest B value groups (less than 25%) while fractures of the tibia/fibula (B = 30%) and foot/toes (B = 40%) fell within the third group. This is in contrast to fractures of the upper extremity where only one diagnostic condition (fracture of the ulna/radius) fell within the second lowest group (B = 17%) while three of the six diagnostic groups fell within the 26–50% range and two within the 51–75% range. The per cent of correctly diagnosed cases is not significantly different for upper vs. lower extremity fracture (55 vs. 53%). The rate of appropriate treatment, however, is substantially greater for lower extremity (54%) as opposed to upper extremity (28%) fractures. A large percentage of upper extremity fracture cases are correctly diagnosed but not treated.

The implications of these findings are substantial for the EMT trainer and system manager. Placing additional emphasis on diagnosing upper extremity fractures in an attempt to improve treatment rates would clearly not be effective. Instead, emphasis should be placed on the importance of providing treatment for all cases diagnosed, regardless of the apparent minimal severity of the signs or symptoms. Although the number of cases with dislocations was too small for a statistically significant comparison, it is notable that the B value for dislocations of the knee/patella is 25% (N = 4), and for shoulder is 53% (N = 15). Again, the pattern of correct diagnosis but inappropriate treatment is more pronounced for the upper extremity condition than the lower extremity condition.

Open soft tissue wounds present consistently high B values, with two (amputated facial part and abrasion) having values between 11 and 25%, and 4 (laceration, amputated digit, puncture wound and animal bite) having values between 26 and 50%. Examination of the A and C values for these cases shows that when the A value is high, the C value tends to be low, whereas when the A value is low (e.g. avulsion = 0%) the C value is higher (58%). This suggests that signs and symptoms, whether or not accompanied by the correct diagnosis, are an important element in determining the provision of appropriate treatment. The implication is that those cases falling with the B cell present with clinical signs and symptoms sufficiently clear to permit the appropriate diagnosis to be made, but not sufficiently severe to prompt the appropriate treatment. Had the signs and symptoms been more severe, even in the absence of the correct diagnosis, the appropriate treatment presumably would have been provided and the case would fall within the C cell. It is important to investigate factors which appear to militate against appropriate treatment being provided in cases which the correct diagnosis has been made; however, one must question whether placing a dressing on a minimal open soft tissue wound (abrasion, "small" laceration, etc.) has any therapeutic value other than to reassure the patient that "something is being done." The concept of mandated treatments does not provide for such flexibility, however, and the dogmatic approach of requiring appropriate treatment to all diagnosed cases would appear acceptable until outcome studies establish different criteria. An alternate strategy is to use the mandated treatment analysis to audit cases and then conduct a review of flagged or deviant cases separately.

The distribution of B cell values for medical cases is quite different and more favorable than for trauma cases. Ten of the 21 medical conditions (48%) have B cell values less than 10% and an addition 7 (33%) have values between 11% and 25%. Of the potentially life-threatening diagnostic conditions of cardiac and respiratory arrest, myocardial infarction, angina (which may masquerade as a myocardial infarction and vice-versa), arrhythmia, pulmonary edema, emphysema, pneumothorax, and smoke inhalation, all have B values less than or equal to 15%, with the exception of arrhythmias, (B = 23%).

It is notable that stroke, seizure, and foreign body in airway all have B values between 58% and

73%. One possible explanation for this, particularly for stroke, is that the mandated treatments may have little apparent correlation with the clinical findings. Mandated treatments for stroke includes the administration of oxygen by mask or nasal cannula. This is a logical physiologic treatment for anoxic tissues, but may not appear indicated in practice, since the patient is usually not "short of breath" or cyanotic. An understanding of the underlying physiology is necessary for the EMT to appreciate why such treatment is important. For seizure and foreign body in airway cases, the mandated treatments (airway management for both and oxygen for foreign body in airway), may be less frequently indicated than the mandate concept would suggest. Patients who have experienced a seizure usually have entered the post-ictal phase by the time the EMT arrives, and the mandated treatments may be only occasionally necessary. The majority of cases of foreign body in the airway represent minor upper airway problems such as a fish bone or tooth pick, and administration of oxygen may well be superfluous.

In spite of the relatively low B values for most medical conditions, it is still disturbing to find that on many occasions even serious cases are correctly diagnosed and yet do not receive the necessary treatments. The conclusion, as stated previously, is that while signs and symptoms may be sufficiently clear for diagnostic purposes, they may not be sufficiently severe to prompt treatment.

In summary, those cases in which a correct diagnosis was made but no treatment instituted (B cell) represent the area for greatest improvement in patient care with presumably the least effort. Having made the correct diagnosis, there are only two valid reasons for not providing a treatment: coexistence of a life-threatening condition (e.g. cardiac arrest) or patient refusal to accept assistance. In this series, cardiac arrest mitigated against other treatment in five cases, all involving multiple trauma. Patient refusal rates were not collected but subjectively appeared to be exceedingly low. Having controlled for the life-threatening situations, there still remained a large number of B cell cases. The EMT may ascribe lack of treatment to the patient not appearing gravely ill, too short a trip to permit institution of treatment, or to "forgetting." Such reasons for non-treatment are not clinically valid and should not be accepted. Those involved in EMT training should probably maintain a dogmatic stand in insisting that, because of the physiology of the underlying disease or injury process, certain diagnoses require treatment regardless of the severity of patient appearance.

The "C" Cell: The "C" values represent an important group in which treatment was apparently based on signs and symptoms, since the diagnosis was either absent or incorrect. Here the EMT does not integrate the available data into a diagnosis, but realizes that certain findings warrant treatment in their own right (Figure III). This suggests that a strong emphasis on physical examination and history taking could enlarge the number of cases in this cell. Placing an emphasis on diagnostic accuracy first with treatment of the diagnosis to follow may be an inadequate approach to training, as is suggested by the B cell values. It is preferrable to have a large C cell value, and hence greater treatment appropriateness, rather than a large B cell value, indicating appropriate diagnosis but inappropriate treatment. A large C cell value may exist when signs and symptoms are severe, but diagnostic accuracy poor (e.g. angina; C = 44%), when a potentially life (or limb) threatening condition may exist, but the signs and symptoms are not necessarily severe (e.g. fracture of thoracic/lumbar spine; C = 82%), or when a difference in terminology between EMT and physician creates an artifact (e.g. avulsion: C = 58%; EMTs diagnose this as "laceration").

The "D" Cell: The "D" cell cases, in which both diagnosis and treatment were incorrect, represent a basic educational problem. Some cases may have too subtle a presentation for the EMT to diagnose, some are atypical, some represent misintegration of data and an error in diagnosis, and some have no signs or symptoms which would themselves warrent treatment. Persistent efforts to increase the EMT's diagnostic capabilities, his skills of observation and examination, and perhaps most of all his experience in dealing with the sick and injured should help reduce D cell values. By determining this value for the spectrum of diagnostic groups, the areas of greatest difficulty can be identified and corrected. In this survey, 28 (48%) of diagnostic groups had a D cell value > 25% (see tables VII–X). An important part of the EMT training should be a continual feedback of information from the hospital concerning the individual's diagnostic accuracy and treatment appropriateness. Such a feedback system should reduce both D and B cell values. It must also be remembered that many diagnostic problems have exceedingly subtle clinical findings, and on occasion may have no presenting signs of symptoms. These cases require electrocardiographic, radiological, and laboratory assistance to identify, and will frequently pose a diagnostic problem for even the most skilled physician. The "silent infarct", the hairline fracture, the early pneumonia, and the intoxicated seizure patient may all present a difficult problem in diagnosis for both EMT and physician. Consequently there will always be cases which fall into the D cell; however, a continuous performance monitoring system coupled with an individually responsive information feedback system should help to maintain D cell values at an acceptable minimal level.

Summary of 2 × 2 Matrix Patterns: In medical training, the usual sequence in problem solving is: history, physicial examination, differential diagnosis, final diagnosis and treatment; each one leading into the next. In EMT training, this is also the basic educational approach; however, the EMT does not receive the same background in anatomy, physiology and pathology that a physician receives, and consequently may have little or no understanding of why certain treatments are essential. In addition, he does not have the sophisticated diagnostic adjuncts, such as electrocardiograms, x-rays and laboratory tests to support his clinical impression. It is, therefore, somewhat artificial to evaluate the adequacy of EMT diagnosis and treatment using physician diagnosed cases as the standard, since it is highly probable that the physician himself would be unable to accurately diagnose many of these conditions solely on the basis of clinical findings. The physician is the pragmatic standard, however, since it is precisely the group he diagnoses that requires the treatments. It is not unreasonable to compare EMT performance against physician-diagnosed cases, but one must avoid the hazard of expecting EMT treatments to be 100% appropriate for physician-diagnosed cases, even under the best of circumstances.

Educators tend to assume that the EMT makes his diagnosis based on signs and symptoms, then treats on the basis of his diagnosis (Figure 2). The data presented suggests that treatments are probably based in large part on signs and symptoms, and only occasionally on diagnosis alone (Figure 3). For the EMT, diagnosis appears to assume a secondary role, often added as an explanation or justification but not included in the treatment logic. When signs and symptoms are neither obvious nor severe, the EMT often elects not to treat. In this sense, he is making a value judgement as to the need for treatment based on his findings, even though he may know that the diagnosis has a mandated treatment. For example, wrist fractures were correctly diagnosed in 93% of cases, yet received appropriate treatment in only 38% and the treatment consistency for all EMT-diagnosed wrist fractures was only 32%. Hyperventilation syndrome was correctly diagnosed in 34% of cases, yet received appropriate treatment in only 4%, and the overall treatment consistency was only 6%. Stroke was diagnosed correctly in 78% of cases, yet appropriately treated in only 26%, and the treatment consistency was only 20%. In many such conditions the diagnosis may be obvious, but the underlying pathophysiology is not well understood. In the absence of such compelling signs and symptoms as shortness of breath, cyanosis, or gross angulation of a fracture, the necessity for treatment may not be apparent and appropriate treatment is frequently not provided.

When one examines the treatment given to those trauma cases where the physician and EMT agree on the diagnosis (Y″), the rate of appropriate treatment tends to be higher than when all cases are examined together (Y′). Exceptions to this, where Y′ is greater than Y″, are usually accompanied by a relatively large C cell value. Presumably, in this subset of cases the signs and symptoms are more obvious, since all patients actually had the diagnosed disorder. The same pattern is seen with non-trauma conditions, although the difference between Y′ and Y″ tends to be less pronounced and where it is small, the C value also tends to be small. For these diagnostic conditions, the signs and symptoms are probably less clear, the underlying pathology more obscure and the need for treatment less well understood. It is apparently easier for the EMT to make a direct link between signs/symptoms and treatment, rather than go through the intermediate step of making a diagnosis, with all the ambiguity and insecurity which that may entail.

Differential Performance Variables

It has been postulated that several variables may be important in explaining why EMT performance is not at a higher level, why some cases are diagnosed and not treated ("Enigma of the 'B' Cell"), and why some cases are neither diagnosed nor treated. Such variables may include: company or service affiliation (commercial, municipal, voluntary); company volume; individual EMT case experience (case volume); pre-EMT training (American Red Cross basic or advanced courses, American Heart Association CPR course, etc.), patient or EMT socioeconomic status, and the presence of concomitant conditions (alcohol use, drug use, psychiatric conditions).

Concomitant Conditions

The previous study (Yale Trauma Program, 1973) suggested that cases presenting with alcohol use, drug use, or a psychiatric condition in addition to an underlying injury or illness might receive a lower rate of appropriate treatment than those without the concomitant conditions. This impression was based on a small number of laceration cases, since no other diagnosis group was sufficiently large for analysis. It was also based on aggregating cases of all three concomitant conditions. In the present study, an analysis of drug use cases could not be carried out, since only 7 of 117 cases had a second diagnosis with mandated treatment. Three cases had respiratory arrest and were treated appropriately and four had lacerations, all treated appropriately. Psychiatric cases (N = 133) also could not be evaluated for treatment appropriateness of secondary diagnoses. Cases involving alcohol use or abuse (N = 313) could be evaluated for the secondary diagnostic groups of lacerations and abrasions. The appropriate treatment rate for laceration cases with concomitant alcohol use (N = 54) was 58% while for all laceration cases was 61%. For abrasion cases (N = 43) the rate of appropriate treatment in the presence of alcohol use was 31% while for all cases it was 39%. When all open soft tissue wounds are aggregated the treatment rate for alcohol use patients was 46% as compared to 54% for the total group.

Two conclusions may be drawn from this data. First, the presence of EMT-perceived alcohol use does seem to have an effect on rate of appropriate treatment, although this effect appears to be minimal. Secondly, it is not possible to clearly demonstrate any effect on treatment rates of concomitant conditions without having an exceedingly large sample of cases. It is estimated that at least 15-20,000 cases in the total sample would be necessary for this evaluation.

Company Type

There were 21 separate companies represented in the survey with a wide distribution in case volume (Table XI). The only "municipal" service (V_6) has been classified with the volunteer services, since it is staffed by five municipal employees who function as drivers, but all attendants (>20) are volunteers. Three commercial companies (C_1, C_3 & C_4) accounted for over 61% of all cases. Commercial companies as a group accounted for 82.7% of cases, while volunteer services carried only 17.3% of cases.

A comparison of individual company (service) performance by diagnostic group (myocardial infraction, pulmonary edema, stroke, laceration, and fractured hip) is presented in Tables XIIA-XVIA. Rates of appropriate treatment vary widely: 49-100% for lacerations, 33-100% for pulmonary edema, 0-50% for stroke; 0-100% for laceration; and 0-100% for fractured hip. Comparing all cases carried by commercial companies and by volunteer services reveals that, of the four diagnostic groups which could be evaluated, the volunteer services performed minimally better on 3 (myocardial infarction: 67% vs. 58%; stroke: 24% vs. 23%; laceration: 60% vs. 59%), while the commercial companies performed significantly better in the fourth group (fractured hip: volunteer = 17%; commercial = 44%). It has been postulated that low case volume, lack of repetition of skills, and a loosely structured system of accountability in volunteer services may result in a lower rate of appropriate treatments. That the volunteer services in this analysis did slightly better than the commercial companies for 3 or 4 diagnostic groups is not as remarkable as that they did not do much worse. The conditions in which they did comparatively well require little skill maintenance, with the possible exception of lacerations. This analysis measures task completion rates and not quality of performance; thus it is possible that the quality of their dressings was not as good as that of the commercial companies, but this was not subjectively observed by the interviewers. It would appear that the cognitive skills of the EMT (diagnostic acumen) are not related to service affiliation, and that simple mechanical skills do not deteriorate with low case volume.

The comparison of fractured hip cases supports this hypothesis. The volunteer services correctly diagnosed all cases (N=6), while the commercial services were correct in only 67% of cases (N=43). Appropriate treatment rates show a reverse pattern, however, with 44% of commercial company cases receiving the mandated treatment, compared to 17% for volunteer service cases. Most cases of fractured hip are managed with a Thomas (or Hare) traction splint. As indicated earlier, correct use of this requires considerable training and practice. The volunteers diagnosed 83% of cases, yet did not treat them (B cell), while the commercials had only 37% in the B cell, and in addition treated 14% on signs and symptoms alone (C cell). This would suggest that complex manual skills may undergo degredation in the absence of repetition, even though cognitive skills may remain intact.

Company Volume

If cases are stratified by company volume, as an index of individual EMT case experience, the findings tend to support the above hypotheses (Tables XII(B) - XVI(b)). Low volume companies have rates of correct diagnosis which are consistently as high as, or higher than, high volume companies. This would suggest that there is no significant degredation in cognitive (diagnostic) skills in spite of low case exposure. A comparison of appropriate treatment rates shows that low volume companies perform as well as, or better than, high volume companies for myocardial infarction and stroke, slightly less well for lacerations, and significantly lower for fractures of the hip. With the exception of laceration cases, low volume companies have higher "B cell" rates than do high volume companies. These results again suggest that while diagnostic skills may remain high, mechanical (treatment) skills, especially those of a complex nature, appear to undergo degredation with lack of repetition.

Individual EMT Case Experience

An analysis of performance of EMT's stratified by age and level of education (Table XVII) using myocardial infarction and laceration as index conditions failed to show any significant performance differences. Stratifying cases by individual EMT (attendant) total case volume for each of five index conditions was done to clarify the possible interaction of skill repetition and appropriate performance (Table XVIII A-E). Of all EMTs surveyed, 68.6% carried less than 11 cases during the study period (Table XVII(A)) as either driver or attendant. Of those listed as "attendant", 61.1% carried fewer than 10 cases, while only 4.4% of attendants carried over 101 cases.

For the five index conditions (myocardial infarction, fractured tibia/fibula, stroke, pulmonary edema, and fractured hip), diagnostic accuracy was higher for high case volume (HCV) EMTs for only one (fractured hip), essentially the same for one (pulmonary edema), and lower for the remaining three conditions when compared to low case volume (LCV) EMTs. Performance for HCV EMTs was higher for three of five conditions (MI, stroke, and pulmonary edema), while lower for two (fractured tibia/fibula and hip). "B cell" values were higher for LCV EMTs for four of five conditions while "D cell" values were higher for four of five conditions for HCV EMTs.

There are several biases which influence these results and make interpretation difficult. All high case volume EMTs work for large commercial companies serving a largely urban population. This population tends to be older and to have lower socioeconomic level than does the suburban population. It also tends to use ambulance services more readily, and frequently with minimal indications. It is entirely possible that the urban population presents with more subtle clinical findings, since they may call earlier and with less provocation. The ready availability of urban ambulance services may result in a broader selection of patient presentations than is found in the suburban population where ambulance services are largely volunteer. An elderly population is more prone to have the given conditions which were investigated, yet most clinicians would agree that diagnosing a "clinical" hip fracture or mild pulmonary edema may be exceedingly difficult without ancillary tests, especially in elderly patients.

In addition to patient selection and presentation biases, patient socio-economic level may be a confounding factor, biasing the EMT's treatment especially with regard to lower SES patients (see next section). The case-load of the EMT may itself bias his performance, in that if he is exceedingly busy, he may be reluctant to take the time to provide an involved treatment (e.g., Thomas splint), or if he is close to the hospital he may decide the treatment is not necessary for the short trip. The EMT does not function alone, but works in a team. While one member (the attendant in this case) may have a LCV, the other may have a HCV. The evaluation is then measuring the combined efforts of both and not the former alone. Regardless of the biases, however, it is the ultimate rate of appropriate treatment which is of paramount importance.

Low case volume EMTs in this survey had higher rates of correct diagnosis than did HCV EMTs. High case volume EMTs appropriately treated the medical conditions of MI, stroke, and pulmonary edema more often than did LCV EMTs. LCV EMTs, however, appropriately treated trauma cases (fractured tibia/fibula and hip) more frequently than did HCV EMTs. Perhaps the most important observations to be made from these results is that diagnostic skills do not seem to degrade even in the face of a low case volume, and treatment of trauma cases remains as high or higher when compared to EMTs with a high case volume. That LCV EMTs had higher "B cell" values for four of five conditions, however, suggests that mechanical skills (or at least treatment practices) do degrade with lack of repetition. That the HCV EMTs also had higher "D cell" values for 4 of 5 cases raises the question of a patient selection or patient presentation bias.

This analysis does not clearly delineate the association of process (appropriate treatment rates) and case volume. It does suggest that diagnostic accuracy may be independent of case volume and that an educational feedback system should be especially beneficial for low case volume EMTs, since they have a high incidence of correct diagnosis in the absence of appropriate treatment (B cell values).

Patient Socioeconomic Status

An analysis of performance by EMT SES was not possible as a result of incomplete EMT SES data and small sample sizes. An analysis of cases by patient SES was possible and the results are presented in Tables XIX and XX. Ten separate diagnostic conditions were selected and cases stratified into quintiles by patient SES (upper, upper middle, lower middle, upper low, and lower low classes). All conditions were then evaluated in the usual manner. Table XX presents the evaluation results for the aggregate of all cases.

Although the numbers tend to be rather small, the general pattern seen in the summary table is repeated frequently in the condition-specific tables. Lower SES groups tend to have slightly higher rates of appropriate treatment than do upper SES groups. Lower SES groups also have lower "B cell" values, suggesting that EMTs may feel more comfortable in treating this group than the upper SES groups, and this appears to substantiate the "role playing" hypothesis. EMTs, especially in an urban setting, tend to have a lower than average SES, and a 12th-grade level of education. They are young and not well paid, and are called upon to play the role of a professional member of the health care team. Playing this role may be difficult when the patient is well educated and an upper-class member, but is probably much easier when the patient is a lower-class member with less education. To the latter patient, the EMT may indeed appear to be "a professional", if only by virtue of his uniform and expensive equipment and vehicle. Of particular importance is that no data suggest that the EMT is unfavorably biased in his treatments of lower SES patients.

Implications for the D.O.T. 81-hour EMT Course

While the results of this evaluation are not nationally generalizable and additional studies in other areas are needed, the methodology for such studies is generalizable. The results, however, still have certain implications for altering both the content and emphasis of the 81-hour DOT course. The course content is basically comprehensive and the time allocated to each general group of diagnostic conditions is roughly proportional to the diagnostic incidence rates. Two significant exceptions are alcohol abuse and psychiatric disorders. Both of these conditions are represented by higher proportion of cases than the time allocated in the course would suggest. Heart, lung and airway disorders are the most life-threatening and offer the greatest possibility for increased patient salvage, but have only mediocre treatment scores. It would seem appropriate to broaden the coverage of these topics and include some of the pathophysiology within the curriculum. The goal of this is not to improve diagnostic accuracy, but to relate the signs and symptoms to the mandated treatments in a meaningful and relevant fashion. Additional time should be allotted for improving treatment capabilities (as opposed to diagnostic accuracy), stressing the need for treatment consistency, and developing a greater familiarity with the indications for treatment. A coronary care unit rotation would seem especially helpful in teaching appropriate treatment patterns for serious medical conditions, and increased observation time in a busy emergency service should provide exposure to fractures and fracture management.

An increased emphasis on obtaining a history as well as eliciting and interpreting signs and symptoms is essential. Treatments should be related to observations in terms of the underlying pathophysiology, not merely through a diagnostic link. The EMT does not appear to treat consistently when he makes a given diagnosis unless he has an understanding of the underlying processes and some appreciation of how his treatments will benefit the patient. He should be a far more reliable attendant if he knows why he should carry out a given treatment. The possible coexistence of diseases with injuries or other medical conditions should also be stressed in the course, and especially the need for examining the alcoholic, drug user and psychiatric patient for signs of subtle or secondary disorders. In this series, treatment of open soft tissue wounds among patients with concomitant alcohol abuse or alcoholism was only 46% as compared to 54% for the total group. Treatments should be provided with consistency, and the EMT should be made aware of the possible effects of personal biases in his treatment patterns.

The necessity for the EMT to "make a correct diagnosis" is open to question. If this approach is to be followed, the concept of mandated treatments must also be emphasized. Certain physical symptoms and many diagnoses, once identified, require definite treatment. It should be made clear within each EMT training course that to diagnose a fracture and not splint it, or to observe a patient with cyanosis and fail to provide oxygen (or assisted ventilation), is negligent. Spending a small amount of additional time within the curriculum dealing with mandated treatments for specific diagnostic groups should increase both diagnostic accuracy and more importantly, the level of appropriate treatments. In the 2 x 2 matrix, this would manifest as increases in Cells A and C, a decrease in D, and should practically eliminate B-cell cases.

Role of the Refresher Training Course

The data presented previously should serve to clarify the role of the 20-hour refresher course in EMT training. The course should not be used to reiterate the 81-hour course in capsule form, but should provide instruction in the improved recognition of manifestations of diseases and injuries, how to obtain a history, formulate a working diagnosis, and initiate appropriate treatment. More importantly, the refresher course should have a changing or dynamic curriculum, designed to address the areas of greatest diagnostic and treatment deficiencies recorded locally. The refresher training course is an opportunity to reduce the diagnosed but not treated group (B) to a minimum by re-emphasizing the mandated treatment concept. It is also an opportunity to reduce the undiagnosed and not treated case rate (D) by reviewing elements of history taking and physical examination. For a refresher course to be responsive to local patterns of EMT performance deficiencies, an ongoing record keeping and quality control system must be implemented. The accumulated performance data should then dictate much of the content of the refresher course. In addition, the record keeping/quality control system should be linked with daily or weekly feedback information from the hospitals to ambulance units and individual EMTs. Periodic information feedback should help maintain a high level of work interest in the EMT and should continue the education process between refresher courses.

Research Priorities

Additional research is necessary to determine the optimal structure of the feedback system proposed above. Several alternative strategies are readily apparent, including periodic feedback of aggregate performance data to all ambulance units, feedback of information aggregated by individual unit to that unit with total aggregated data available as a comparison. Provision of feedback linked to follow-up training, using either the system operator/manager, an EMT trainer, or a physician as instructor. The instructor may then work with either groups or individual EMTs to improve performance in identified problem areas.

Research to identify the optimal configuration of feedback system elements will require a highly controlled environment with an existing quality control (performance evaluation) and data keeping system, large numbers of EMTs and patients, and the ability to group EMTs into separate "treatment" groups for exposure to differing forms of feedback instruction. The results of such a research project would have tremendous implications. They would establish the practical utility of record keeping and quality control system in improving performance, and additionally demonstrate the optimal constellation of feedback system elements: individual vs. aggregate data feedback, individual vs. group retraining, and system manager vs. EMT trainer vs. physician teaching within the feedback system. Such research would hopefully allow one to assess the various tradeoffs between improved performance with alternative feedback systems and the cost entailed with each system. This would allow system operators or EMS councils to select the optimal balance between cost and benefit.

Research is also necessary to establish the impact of EMT mandated treatments on patient outcomes. It is quite possible that certain mandated treatments, under close examination, would be shown to be of little or no value. One could certainly question the necessity of dressing an abrasion, puncture wound, or most animal bites. Where mandated treatments can be shown to improve outcomes they should be retained and reinforced; where such may not be the case, they should be discarded or made optional. Development of a weighting system for mandated treatments is also necessary. Clearly, providing CPR is more important than dressing an abrasion, and splinting a spine more important than splinting a finger. Any attempt to develop an overall EMT performance index must include such a system of treatment priorities (weights).

Finally, research is necessary to determine ways to assess the quality of EMT treatments and not merely measure task completion rates. If the treatment appropriateness factors are all high, but the treatments are administered improperly or inadequately, they will not benefit the patient. Observation of EMTs in the field and the development of appropriate devices to assess the quality of care is critical.

Summary

An evaluation was conducted of the diagnostic accuracy and treatment appropriateness of EMTs in caring for 4,455 consecutive patients during a 4½ month period. Patient-specific clinical information including EMT diagnosis and treatment, and physician diagnosis was collected on a one-page instrument and EMT data validated by observers. There were 58 diagnostic conditions for which treatments could be mandated as determined by a physician panel. There were 2,233 (50%) patients with 2401 separate diagnoses for which mandated treatments were applicable. Cases were grouped by physician diagnosis and EMT diagnostic accuracy was measured using physician diagnosis as the standard. Rates of appropriate treatment were determined by measuring compliance with the list of mandated treatments.

The evaluation of EMT performance demonstrated the level of effectiveness of the EMT, his diagnostic accuracy, and his rate of appropriate interventions. Diagnostic accuracy tends to be mediocre, but treatment appropriateness varies by diagnosis and severity. Life-threatening or serious medical and trauma conditions receive appropriate treatment far more frequently than nonserious conditions. Appropriate treatments are more often based on observed signs and symptoms than on diagnosis, and are also more frequently provided when signs and symptoms are severe than when not. The evaluation supports the general format and content of the 81-hour EMT-A course, but points out several areas where a change in educational approach and emphasis is essential. It also clarifies the role of the Refresher Training Course. Variations in diagnostic accuracy and therapeutic appropriateness may be accounted for by numerous variables, but probably not the course curriculum per se. Accordingly, such problems must be corrected at the local level through re-education and refresher courses and through frequent feedback of relevant information. Additonal research is necessary to clarify the optimal strategy for implementing such a feedback system.

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Figures and Tables

Figure 1: Diagnostic/treatment matrix

		Treatment	
		Appropriate (+)	Inappropriate (–)
Diagnosis	Correct (+)	A(+,+)	B(+,–)
	Incorrect (–)	C(–,+)	D(–,–)

Figure 2

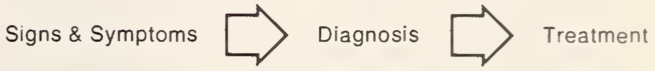


Figure 3

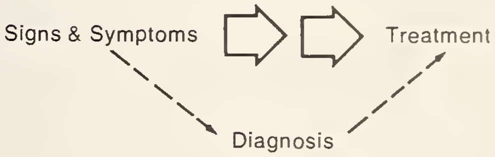


Table I: EMT mandated treatments by diagnosis

HEART, LUNG and AIRWAY

1. Cardiac Arrest:
   1) cardiopulmonary resuscitation
2. Respiratory Arrest:
   1) assisted ventilation
   2) airway
   3) suction
3. Myocardial Infarction:
   1) oxygen (mask or nasal cannula) or assisted ventilation
   2) position (head up, sitting, supine or comfort)
   3) reassurance
4. Angina:
   1) oxygen (mask or nasal cannula) or assisted ventilation
   2) position (head up, sitting or comfort)
   3) reassurance
5. Arrhythmia:
   1) oxygen (mask or nasal cannula) or assisted ventilation
   2) position (supine, head up, sit, comfort)
6. Pulmonary Edema:
   1) position (head up, sit or comfort)
   2) oxygen (mask or nasal cannual or assisted ventilation
   3) reassurance
7. Emphysema (chronic obstructive pulmonary disease):
   1) oxygen (mask or nasal cannula) or assisted ventilation
   2) position (head up, sitting, or comfort)
   3) reassurance
8. Asthma:
   1) position (sitting, head up or comfort)
   2) reassurance
9. Pneumonia:
   1) oxygen (mask or nasal cannula) or assisted ventilation
   2) position (supine, head up, sti, comfort)
10. Pneumothorax:
    1) oxygen (mask or nasal cannula) or assisted ventilation
    2) position (supine, head up, sit, comfort)
    3) reassurance
11. Smoke Inhalation:
    1) oxygen (mask or nasal cannula) or assisted ventilation
    2) position (head up, sit, or comfort)
12. Stroke (C.V.A.):
    1) oxygen (mask or nasal cannula) or assisted ventilation
    2) position (supine, side, or prone)
13. Seizure:
    1) airway management (bite block, oral or nasal airway or suction)
    2) position (side or prone)
14. Foreign Body in Airway:
    1) clear airway or suction
    2) oxygen
    3) resuscitation

MISCELLANEOUS MEDICAL CONDITIONS

15. Hyperventilation Syndrome:
    1) paper bag rebreathe
    2) reassurance
16. Carbon Monoxide Poisoning:
    1) oxygen (mask, nasal cannula) or assisted ventilation if not breathing
17. Drowning:
    1) CPR, or oxygen with assisted ventilation (if pulse present)
    2) CPR, or O_2 by mask/cannula (if pulse and spontaneous respiration present
18. Unconscious States (not included in other diagnostic groups):
    1) position: side, prone, supine
19. Ruptured Viscus:
    1) position, head up or comfort
20. Infections or Inflammatory Abdominal disease:
    1) position: supine, head up or comfort position
21. Psychiatric Illness:
    1) reassurance
22. Upper Respiratory Infection:
    1) reassurance
23. Suicide Gesture:
    1) reassurance
24. Insulin Shock:
    1) none (note: EMTs did not carry glucose in vehicles)
25. Drug Overdose:
    1) none
26. Alcohol Ingestion or Alcoholism:
    1) none
27. Upper Gastrointestinal Bleeding:
    1) none
28. Lower Gastrointestinal Bleeding:
    1) none

FRACTURES

29. Cervical Spine Fracture:
    1) short or long backboard *and* cervical collar or sand bag
    2) position (supine, side, or prone)
30. Thoracic or Lumbar Spine Fracture:
    1) long backboard or scoop
31. Fracture of Sacrum or coccyx:
    1) long backboard or scoop
32. Fractured Pelvis:
    1) sling, sling/swathe or air arm or board with swathe
34. Fractured Humerus:
    1) sling, sling/swathe, or air arm or board with swathe
35. Fractured Elbow:
    1) sling, sling/swathe, board, or pillow
36. Fractured Ulna and/or Radius:
    1) board, air arm, or sling/swathe
37. Fractured Wrist:
    1) board, air arm, sling/board, pillow
38. Fractured Hand/Finger:
    1) board or air arm spling
39. Fractured Hip:
    1) splint (Thomas), long backboard, or scoop
40. Fractured Femur:
    1) splint (Thomas or traction, board, or long backboard)
    2) rx:) above splints or scoop (judged marginally acceptable)
41. Fractured Knee/Patella:
    1) splint (Thomas, long leg air, board, pillow or long backboard)
42. Fractured Tibia and/or Fibula:
    1) splint (Thomas, long leg air, board)
43. Fractured Ankle:
    1) splint (Thomas, long or short leg air, board pillow)
44. Fractured Foot/Toes:
    1) splint (any)
45. Fractured Skull:
    1) none
46. Fractured Facial Bone:
    1) none

DISLOCATIONS

48. Dislocated Shoulder:
    1) sling or sling/swathe
49. Dislocated Elbow:
    1) sling, sling/swathe, air arm, board or full-arm pillow
50. Dislocated Wrist:
    1) air arm, board or pillow splint
51. Dislocated Hip:
    1) long backboard, scoop with pillow or Thomas splint
52. Dislocated Knee/Patella:
    1) long backboard, board, Thomas, or long leg air splint
53. Dislocated Ankle:
    1) long or short leg air, board, or pillow splint

OPEN SOFT TISSUE INJURIES

54. Laceration:
    1) dressing
55. Avulsion:
    1) dressing

Table I: EMT mandated treatments by diagnosis—(continued)

56. Amputated Facial Part:
    1) dressing

57. Amputated digit:
    1) dressing

58. Abrasion:
    1) dressing

59. Puncture Wound:
    1) dressing

60. Animal Bite:
    1) dressing

BURNS

61. Chemical:
    1) irrigation
    1) dressing

62. First Degree:
    1) none

63. Second Degree:
    1) dressing or burn sheet

64. Third Degree:
    1) dressing or burn sheet

MISCELLANEOUS TRAUMA

65. Snake Bite:
    1) tourniquet
    2) position (any except walking or sitting)
    3) dressing (immobilizing or splint)

66. Ruptured (Lacerated) Liver and/or Spleen:
    1) position (shock or supine)

67. Hemothorax:
    1) oxygen (mask or nasal cannual)
    2) position (shock, supine, or comfort)
    3) reassurance

Table II (A): Diagnostic mix of ambulance cases

Diagnosis (M.D.)	*N*	*% of Completed Cases (4150)*	*% of Cases with Mandated Treatment (2401)*
Cardiac Arrest	77	1.86	3.21
Respiratory Arrest	14	0.43	0.58
Myocardial Infarction	86	4.48	7.75
Angina	27	0.65	1.12
Arrhythmia	30	0.72	1.25
Pulmonary Edema	24	0.58	1.00
Emphysema	41	0.99	1.71
Asthma	51	1.23	2.12
Pneumonia	67	1.61	2.79
Pneumothorax	11	0.27	0.46
Smoke Inhalation	4	0.10	0.17
Stroke	106	2.55	4.41
Seizure	130	3.13	5.41
F.B. in airway	15	0.36	0.62
Hyperventilation Synd.	152	3.66	6.33
Carbon Monoxide Pois.	1	0.02	0.04
Drowning	2	0.05	0.08
Unconsciousness	5	0.12	0.21
Ruptured Viscus	1	0.02	0.04
Infect./Inflam. Abd. Dis.	97	2.34	4.04
Psychiatric Illness	133	3.20	5.54
Upper Resp. Infection	49	1.18	2.04
Suicide Gesture	18	0.43	0.75
Insulin Shock	23	0.55	—
Drug Overdose	117	2.82	—
Alcohol effect (ism)	313	7.54	—
Lower G.I. Bleed	10	0.24	—
Upper G.I. Bleed	26	0.63	—
Fracture of:			
Cervical Spine	3	0.07	0.12
Th/Lumbar Spine	11	0.27	0.46
Sacrum/Coccyx	2	0.05	0.08
Pelvis	11	0.27	0.46
Clavicle	12	0.29	0.50
Humerus	24	0.58	1.00
Elbow	2	0.05	0.08
Ulna/Radius	24	0.58	1.00
Wrist	13	0.31	0.54

Diagnosis (M.D.)	*N*	*% of Completed Cases (4150)*	*% of Cases with Mandated Treatment (2401)*
Fracture of:			
Hand/Finger	13	0.31	0.54
Hip	49	1.18	2.04
Femur	20	0.48	0.83
Knee/Patella	13	0.31	0.54
Tibia/Fibula	33	0.80	1.37
Ankle	18	0.43	0.75
Foot/Toes	5	0.12	0.21
Skull	20	0.48	—
Facial Bones	30	0.72	—
Mandible	7	0.17	—
Dislocations of:			
Shoulder	15	0.36	0.62
Elbow	3	0.07	0.12
Wrist	1	0.02	0.04
Hip	1	0.02	0.04
Knee/Patella	4	0.10	0.17
Ankle	2	0.05	0.08
Open Soft Tissue Injuries:			
Laceration	531	12.80	22.12
Avulsion	12	0.29	0.50
Amp. Facial Part	12	0.29	0.50
Amp. Digit	5	0.12	0.21
Abrasion	239	5.76	9.95
Puncture Wound	37	0.89	1.54
Animal Bite	8	0.19	0.33
Burns:			
Chemical	1	0.02	0.04
Thermal: 1$_o$	10	0.24	—
2$_o$	12	0.29	0.50
3$_o$	4	0.10	0.17
Miscellaneous Trauma:			
Snake Bite	11	0.27	0.46
Rupt. Liver/Spleen	6	0.14	0.25
Hemothorax	3	0.07	0.12

Table II (B): Diagnostic incidence of ambulance cases

(Non-mandated Treatment Cases)

Diagnosis (M.D.)	*N*	% of *Total Sample (4,454)*
No observable injury or illness	503	11.29
Sprains other than back	29	0.65
Back pain/sprain including disc disease	72	1.61
Contusions	373	8.35
Concussion/cerebral contusion	63	1.41
Epistaxis	9	0.20
Abd pain (unspec.) includes renal colic, PID, ulcer pain, pancreatitis	43	0.96
Hernia (not obstructed)	8	0.18
Intestinal obstruction	7	0.16
Urinary retention	8	0.18
Urinary tract infection	17	0.38
Cancer (including tumor and leukemia)	49	1.10
Constipation/fecal impaction	13	0.29
Headache	10	0.22
Abscess	11	0.25
Faint (snycope)	69	1.55
Pregnancy and spontaneous abortion	20	0.45
Anemia	7	0.16
Delerium tremens	6	0.13
Diabetes	38	0.85
Diarrhea	3	0.07
Transient cerebral ischemia attach (TIA)	21	0.47
Fever of unknown cause	15	0.34
Otitis media	6	0.13
Meningitis	3	0.07
Non-specific gynecologic problems (i.e. vaginitis, etc.)	19	0.43
Total %		31.88

Table III: Medical cases: diagnosis and treatment by groups

A. Major

	#N	#A+B	%A+B	#A+C	%A+C
All Heart, lung, and airway problems	783	448	57%	376	48%
Cardiac & resp. arrest M.I., angina, C.O.P.D. arrhythmia, C.H.F.	399	209	52%	261	65%

B. Minor

	#N	#A+B	%A+B	#A+C	%A+C
Misc. Med. Probs	947	452	48%	187[a]	41%[a]

C. Totals

	#N	#A+B	%A+B	#A+C	%A+C
All medical probs	1730	900	52%	563[b]	45%[b]

Notes: a. only 458 cases with mandated Rxs
b. only 1241 cases with mandated Rxs

Table IV: Fractures: diagnosis and treatment by region

	#N	#A+B	%A+B	#A+C	%A+C
Spine & pelvis	27	6	22%	19	70%
Lower extremity	138	76	55%	74	54%
Upper extremity	88	47	53%	25	28%
Totals	253	129	51%	11	47%

Table V: Dislocations: diagnosis and treatment by region

	#N	#A+B	%A+B	#A+C	%A+C
Upper extremity	19	14	79%	8	42%
Lower extremity	7	3	43%	4	57%

Table VI: Soft tissue injuries

A. Open Wounds

		#N	#A+B	%A+B	#A+C	%A+C
ALL	Lacerations Abrasions Bites Puncture wounds, etc.	844	573	68%	458	54%
All except abrasions		605	488	81%	365	60%

B. Burns

	#N	#A+B	%A+B	#A+C	%A+C
All including Chemical	27	21	78%	14	82% (of 17[a])

Notes: a. all 1° burns omitted (no Rx)

Table VII (A): Heart, lung & airway

	Based on MD Dx					*Based on EMT Dx*		
Diagnosis	N	%A	%B	%C	%D	N	%A	%C
Cardiac arrest	77	74	9	6	10	89	64	19
Resp. arrest	14	21	7	43	29	12	25	50
Myocardial infarct	186	39	15	24	22	212	34	40
Angina	27	19	4	44	33	29	17	45
Arrhythmia	30	7	23	30	40	19	11	21
Pulmonary edema	24	38	4	46	13	33	24	70
Emphysema	41	27	12	34	27	29	38	17
Asthma	51	49	22	22	7	54	46	22
Pneumonia	67	7	15	34	43	30	17	13
Pneumothorax	11	9	9	18	64	4	25	0
Smoke inhal.	4	100	0	0	0	7	57	14
Stroke	106	20	58	7	15	155	17	10
Seizure	130	11	55	0	34	149	9	8
F.B. in airway	15	13	73	0	13	24	8	8

Table VII (B): Diagnostic factors—heart, lung & airway

Diagnosis	*Total %* A+B	X	X'	Sel.	X''	Spec.
Cardiac arrest	83	72	17	83	28	72
Resp. arrest	28	33	71	29	67	33
Myocardial infarct	54	47	46	54	53	47
Angina	23	21	67	33	79	21
Arrhythmia	30	47	70	30	53	47
Pulmonary edema	42	30	58	42	70	30
Emphysema	39	55	61	39	45	55
Asthma	71	67	29	71	33	67
Pneumonia	22	50	78	22	50	50
Pneumothorax	18	50	82	18	50	50
Smoke inhal.	100	57	0	100	43	57
Stroke	78	54	22	78	46	54
Seizure	66	58	34	66	42	58
F.B. in airway	86	54	13	87	46	54

Table VII (C): Treatment factors—heart, lung, & airway

Diagnosis	Y	Y'	Y''	Y°	Y^{u}
Cardiac arrest	83	81	89	22	19
Resp. arrest	75	64	75	40	36
Myocardial infarct	71	60	68	42	40
Angina	62	63	83	43	37
Arrhythmia	32	37	22	27	63
Pulmonary edema	73	83	90	43	17
Emphysema	55	61	69	17	39
Asthma	69	71	69	25	29
Pneumonia	30	42	33	13	58
Pneumothorax	25	27	50	0	73
Smoke inhal.	71	100	100	20	0
Stroke	20	26	25	26	74
Seizure	17	11	16	46	89
F.B. in airway	17	13	15	50	87

Table VII (D): Diagnosis/treatment comparison—heart, lung, & airway

Diagnosis	Bi Dxi	Ai Dxi	Y	Y''	Y'''
Cardiac arrest	11	92	83	89	68
Resp. arrest	25	67	75	75	75
Myocardial infarct	32	61	71	68	73
Angina	17	29	62	63	57
Arrhythmia	78	18	32	22	40
Pulmonary edema	10	45	73	90	65
Emphysema	31	44	55	69	38
Asthma	31	69	69	69	67
Pneumonia	67	18	30	33	27
Pneumothorax	50	33	25	50	0
Smoke inhal.	0	100	71	100	33
Stroke	75	75	20	25	14
Seizure	84	1.0	17	16	19
F.B. in airway	85	100	17	15	18

Table VIII (A): Misc. medical conditions

Diagnosis	Based on MD Dx					Based on EMT Dx		
	N	%A	%B	%C	%D	N	%A	%C
Hypervent. synd.	152	3	31	1	65	130	4	2
Carbon monoxide pois.	1	100	0	0	0	1	100	0
Drowning	2	0	0	100	0	0	0	0
Unconscious	5	20	0	0	80	22	5	55
Ruptured viscus	1	0	0	100	0	0	0	0
Infectious/Inflam. abdominal cond.	97	19	14	37	30	52	35	21
Psychiatric illness	133	35	22	28	16	128	36	23
Upper resp. inf.	49	16	8	43	33	30	27	43
Suicide gesture	18	0	6	56	39	10	0	40
Insulin shock	23	-	-	-	-	20	-	-
Drug overdose	117	-	-	-	-	138	-	-
Alcohol effect(ism)	313	-	-	-	-	138	-	-
Lower GI bleed	10	-	-	-	-	7	-	-
Upper GI bleed	26	-	-	-	-	25	-	-

Table VIII (B): Diagnostic factors—misc. medical conditions

Diagnosis	Total % A+B	X	X'	Sel.	X''	Spec.
Hypervent synd.	34	40	66	34	60	40
Carbon monoxide pois.	100	100	0	100	0	100
Drowning	0	0	100	0	0	100
Unconscious	20	4	80	20	96	4
Ruptured viscus	0	~	100	0	~	~
Infectious/Inflam abdominal cond.	33	62	67	33	38	62
Psychiatric illness	57	59	44	56	41	59
Upper resp. inf.	24	40	76	24	60	40
Suicide gesture	6	10	94	6	90	10
Insulin shock	52	60	48	52	40	60
Drug overdose	78	66	22	78	34	66
Alcohol effect(ism)	51	59	49	51	41	59
Lower GI bleed	20	28	80	20	71	29
Upper GI bleed	50	52	50	50	48	52

Table VIII (C): Treatment factors— misc. medical conditions

Diagnosis	Y	Y'	Y''	Y°	Y^{u}
Hypervent. synd.	6	4	10	33	96
Carbon monoxide pois.	100	100	100	0	0
Drowning	0	100	—	0	0
Unconscious	50	20	100	92	80
Ruptured viscus	~	100	~	0	0
Infectious/Inflam. abdominal cond.	56	56	56	17	44
Psychiatric illness	59	62	61	26	38
Upper resp. inf.	70	59	67	31	41
Suicide gesture	40	56	0	29	44
Insulin shock	-	-	-	-	-
Drug overdose	-	-	-	-	-
Alcohol effect(ism)	-	-	-	-	-
Lower GI bleed	-	-	-	-	-
Upper GI bleed	-	-	-	-	-

Table VIII (D): Diagnosis/treatment comparison—misc. medical conditions

Diagnosis	Bi Dxi	Ai Dxi	Y	Y''	Y'''
Hypervent. synd.	90	83	6	10	4
Carbon monoxide pois.	0	100	100	100	0
Drowning	0	0	0	~	
Unconscious	0	100	59	100	57
Ruptured viscus	0	0	~	~	~
Infectious/Inflam abdominal cond.	44	33	56	56	55
Psychiatric illness	39	55	59	61	55
Upper resp. inf.	33	29	70	67	28
Suicide gesture	100	0	40	0	44
Insulin shock	-	-	-	-	-
Drug overdose	-	-	-	-	-
Alcohol effect(ism)	-	-	-	-	-
Lower GI bleed	-	-	-	-	-
Upper GI bleed	-	-	-	-	-

Table IX (A): Fractures

			Based on MD Dx			*Based on EMT Dx*		
Diagnosis	N	%A	%B	%C	%D	N	%A	%C
Cervical spine	3	67	0	33	0	19	11	42
Th/Lumber spine	11	0	9	82	9	10	0	50
Sacrum/coccyx	2	0	0	50	50	0	0	0
Pelvis	11	18	9	36	36	8	50	25
Clavicle	12	17	33	17	33	20	10	10
Humerus	24	17	29	4	50	28	14	21
Elbow	2	0	50	50	0	7	0	29
Ulna/radius	24	25	17	17	42	25	24	32
Wrist	13	31	62	8	0	25	16	16
Hand/finger	13	0	54	0	46	14	0	7
Hip	49	53	18	14	14	61	43	23
Femur	20	40	5	45	10	28	29	50
Knee/patella	13	0	0	46	54	14	0	64
Tibia/fibula	33	24	30	18	27	40	20	28
Ankle	18	44	17	11	28	48	17	58
Foot/toes	5	20	40	0	40	7	14	29
Skull	20	-	-	-	-	15	-	-
Facial bones	30	-	-	-	-	27	-	-
Mandible	7	-	-	-	-	4	-	-

Dislocations

			Based on MD Dx			*Based on EMT Dx*		
Diagnosis	N	%A	%B	%C	%D	N	%A	%C
Shoulder	15	20	53	7	20	24	13	4
Elbow	3	100	0	0	0	8	38	13
Wrist	1	0	0	100	0	1	0	100
Hip	1	0	1	100	0	6	0	67
Knee/patella	4	50	25	0	25	10	20	40
Ankle	2	0	0	50	50	1	0	100

Table IX (B): Diagnostic factors—fractures

Diagnosis	*Total %* A+B	X	X'	Sel.	X"	Spec.
Cervical spine	67	11	33	67	89	11
Th/Lumber spine	9	10	91	9	90	10
Sacrum/coccyx	0	0	100	0	0	100
Pelvis	27	38	73	27	63	37
Clavicle	50	30	50	50	70	30
Humerus	33	39	54	46	61	39
Elbow	50	14	50	50	86	14
Ulna/radius	42	24	58	42	60	40
Wrist	93	48	8	92	52	48
Hand/finger	54	50	46	54	50	50
Hip	71	57	29	71	43	57
Femur	45	32	55	45	75	25
Knee/patella	0	0	100	0	100	0
Tibia/fibula	54	45	45	55	55	45
Ankle	61	23	39	61	77	23
Foot/toes	60	43	40	60	57	43
Skull	35	46	65	35	53	47
Facial bones	53	59	46	54	40	60
Mandible	43	75	57	43	25	75

Dislocations

Diagnosis	*Total %* A+B	X	X'	1−X'	X"	1−X"
Shoulder	73	46	27	73	54	46
Elbow	100	38	0	100	63	37
Wrist	0	0	100	0	100	0
Hip	0	0	100	0	100	0
Knee/patella	75	30	25	75	70	30
Ankle	0	0	100	0	100	0

Table IX (C): Treatment factors—fractures

Diagnosis	Y	Y'	Y"	Y^{o}	Y^{u}
Cervical spine	53	100	100	73	0
Th/Lumber spine	50	82	0	36	18
Sacrum/coccyx	a	50	0	0	50
Pelvis	75	54	67	40	45
Clavicle	20	34	33	33	67
Humerus	36	21	36	55	79
Elbow	28	50	0	67	50
Ulna/radius	56	42	60	44	58
Wrist	32	38	33	44	62
Hand/finger	0	0	0	100	100
Hip	66	67	74	30	33
Femur	79	85	89	55	15
Knee/patella	64	46	0	60	54
Tibia/fibula	48	42	44	44	58
Ankle	75	55	73	74	44
Foot/toes	43	20	33	67	80
Skull	-	-	-	-	-
Facial bones	-	-	-	-	-
Mandible	-	-	-	-	-

Dislocations

Diagnosis	Y	Y'	Y"	Y^{o}	Y^{u}
Shoulder	17	27	27	20	73
Elbow	50	100	100	25	0
Wrist	100	100	b	50	0
Hip	67	100	0	80	0
Knee/patella	60	50	67	67	50
Ankle	100	50	0	50	50

Footnotes:
a E Dx = 0
b A+B = 0

Table IX (D): Diagnosis/treatment comparison—fractures

Diagnosis	Bi Dxi	Ai Dxi	Y	Y''	Y'''
Cervical spine	0	67	53	100	47
Th/Lumbar spine	~	0	50	0	56
Sacrum/coccyx	0	0	~	0	0
Pelvis	33	33	75	67	83
Clavicle	67	50	20	33	14
Humerus	64	80	36	36	35
Elbow	100	~	28	0	33
Ulna/radius	40	60	56	60	53
Wrist	67	80	32	33	31
Hand/finger	100	0	0	0	14
Hip	26	79	66	74	54
Femur	11	47	79	89	74
Knee/Patella			64	0	64
Tibia/fibula	56	57	48	44	55
Ankle	27	80	75	73	76
Foot/toes	67	100	43	33	50
Skull	-	-	-	-	-
Facial bones	-	-	-	-	-
Mandible	-	-	-	-	-

Dislocations

Diagnosis	Bi Dxi	Ai Dxi	Y	Y''	Y'''
Shoulder	73	75	17	27	8
Elbow	0	100	50	100	20
Wrist	0	0	100	~	100
Hip	0	0	67	0	67
Knee/patella	33	100	60	67	57
Ankle	0	0	100	0	100

Table X (A): Open soft tissue injuries

			Based on MD Dx			Based on EMT Dx		
Diagnosis	N	%A	%B	%C	%D	N	%A	%C
Laceration	531	53	30	8	9	601	47	16
Avulsion	12	0	0	58	42	10	0	90
Amp. facial part	12	17	25	33	25	18	11	39
Amp. digit	5	60	40	0	0	7	43	14
Abrasion	239	17	19	22	42	150	27	17
Puncture wound	37	54	30	5	11	45	44	20
Animal bite	8	38	38	12	12	19	16	16

Burns

			Based on MD Dx			Based on EMT Dx		
Diagnosis	N	%A	%B	%C	%D	N	%A	%C
Chemical	1	100	0	0	0	1	100	0
Thermal: 1°	10	-	-	-	-	9	-	-
2°	12	75	17	0	8	12	75	0
3°	4	50	0	50	0	3	67	33

Misc. trauma

			Based on MD Dx			Based on EMT Dx		
Diagnosis	N	%A	%B	%C	%D	N	%A	%C
Snake bite	11	0	64	0	36	9	0	0
Rupt. liver/spleen	6	17	0	50	33	6	17	83
Hemothorax	3	0	0	67	33	0	0	0

Table X (B): Diagnostic factors—open soft tissue injuries

Diagnosis	*Total %* A+B	X	X'	Sel.	X''	Spec.
Laceration	83	73	17	83	27	73
Avulsion	0	0	100	0	100	0
Amp. facial part	42	28	58	42	72	28
Amp. digit	100	1	0	100	29	71
Abrasion	36	57	64	36	43	57
Puncture wound	84	69	16	84	31	69
Animal bite	76	32	25	75	68	32

Burns

Diagnosis	*Total %* A+B	X	X'	Sel.	X''	Spec.
Chemical	100	100	0	100	0	100
Thermal: 1°	70	78	30	70	22	78
2°	92	92	8	92	8	92
3°	50	67	50	50	33	67

Misc. trauma

Diagnosis	*Total %* A+B	X	X'	Sel.	X''	Spec.
Snake bite	64	77	36	64	22	78
Rupt. liver/spleen	17	17	83	17	83	17
Hemothorax	0	0	100	0	0	100

Table X (C): Treatment factors—open soft tissue injuries

Diagnosis	Y	Y'	Y''	Y°	Y^u
Laceration	63	61	64	23	39
Avulsion	90	58	0	56	42
Amp. facial part	50	50	40	54	50
Amp. digit	57	60	60	25	40
Abrasion	43	39	47	21	61
Puncture wound	64	59	65	29	41
Animal bite	32	50	50	43	50

Burns

Diagnosis	Y	Y'	Y''	Y°	Y^u
Chemical	100	100	100	0	0
Thermal: 1°	-	-	-	-	-
2°	75	75	82	0	25
3°	100	100	100	20	0

Misc. trauma

Diagnosis	Y	Y'	Y''	Y°	Y^u
Snake bite	0	0	0	0	0
Rupt. liver/spleen	100	67	100	56	33
Homothorax	0	67	0	0	33

Table X (D): Diagnosis/treatment comparison—open soft tissue injuries

Diagnosis	Bi Dxi	Ai Dxi	Y	Y''	Y'''
Laceration	36	87	63	64	59
Avulsion	0	0	90	0	90
Amp. facial part	60	33	50	40	54
Amp. digit	40	100	57	60	50
Abrasion	53	43	43	47	38
Puncture wound	35	91	64	65	64
Animal bite	50	75	32	50	23

Burns

Diagnosis	Bi Dxi	Ai Dxi	Y	Y''	Y'''
Chemical	0	100	100	100	0
Thermal: 1°	-	-	-	-	-
2°	18	100	75	82	0
3°	0	50	100	100	100

Misc. trauma

Diagnosis	Bi Dxi	Ai Dxi	Y	Y''	Y'''
Snake bite	0	0	0	0	0
Rupt. liver/spleen	0	25	100	100	100
Hemothorax	0	0	0	0	0

Table XI. Ambulance cases by company

	N	% of Total (4454)
C_1	907	20.37
C_2	300	6.74
C_3	838	18.81
C_4	1000	22.45
C_5	241	5.41
C_6	337	7.57
C_7	1	0.02
C_8	24	0.54
C_9	4	0.09
C_{10}	18	0.40
C_{11}	14	0.31
V_1	52	1.17
V_2	20	0.45
V_3	17	0.38
V_4	1	0.02
V_5	9	0.20
V_6	98	2.20
V_7	5	0.11
V_8	1	0.02
V_9	3	0.07
V_{10}	137	3.08

Table XII (A): Myocardial infarction case treatment by ambulance company

N=186

Company	N	%A	%B	%C	%D	%A&B	%A&C
C_1	36	33	8	28	31	41	61
C_2	8	50	0	38	12	50	88
C_3	34	29	27	29	19	52	58
C_4	47	34	15	15	36	49	49
C_5	18	33	22	28	17	55	61
C_6	13	54	31	8	8	85	62
C_8	7	43	14	14	29	57	57
C_{10}	1	0	0	100	0	0	100
V_1	2	50	0	50	0	50	100
V_2	2	50	0	50	0	50	100
V_6	10	30	40	20	10	70	50
V_7	1	100	0	0	0	100	100
V_9	1	100	0	0	0	100	100
V_{10}	8	50	25	12	12	75	62
All C	164	35	16	23	25	46	58
All V	24	46	25	21	8	71	67

Table XII (B): Myocardial infarction case treatment by company total case volume

Cases/4 mo	#Co's	Total MI Cases	%A	%B	%C	%D	%A&B	%A&C
500-1,000	3	117	32	15	22	29	47	54
200-499	3	39	44	21	23	13	65	67
100-199	1	8	50	25	12	12	75	62
50-99	2	12	33	33	25	8	66	58
<50	3*	4	75	0	25	0	75	100

* Two commercial companies with low case volume in this study deleted, since >90% of their cases transported to non-survey (out of region) hospitals and total volume is >200 cases.

Table XIII (A): Pulmonary edema case treatment by ambulance company

N=24

Company	N	%A	%B	%C	%D	%A&B	%A&C
C_1	7	29	0	57	14	29	86
C_3	4	25	25	50	0	50	75
C_4	8	37	50	0	49	87	0
C_5	1	100	0	0	0	100	100
C_6	3	33	0	0	67	33	33
V_6	1	0	0	100	0	0	100
all C	23	35	9	43	13	44	78

Table XIII (B): Pulmonary edema case treatment by company total case volume

Cases/4 mo	#Co's	Total PE Cases	%A	%B	%C	%D	%A&B	%A&C
500-1,000	3	19	32	11	53	5	44	85
200-499	2	4	50	0	0	50	50	50

Table XIV (A): Stroke (CVA) case treatment by ambulance company

N=106

Company	N	%A	%B	%C	%D	%A&B	%A&C
C_1	11	36	27	9	27	63	45
C_2	15	20	60	13	7	80	33
C_3	21	24	62	0	14	66	24
C_4	27	7	67	4	22	74	11
C_5	8	0	88	0	12	88	0
C_6	7	14	57	14	14	71	28
V_1	1	0	100	0	0	100	0
V_2	2	50	0	0	50	50	50
V_6	4	25	50	25	0	75	50
V_{10}	7	14	86	0	0	100	14
Other	3	0	67	0	33	67	0
All C	89	17	61	6	17	78	23
All V & oth.	17	18	65	6	12	83	24

Table XIV (B): Stroke case treatment by company total case volume

N=106

Cases/4 mo	#Co's	Total Stroke cases	%A	%B	%C	%D	%A&B	%A&C
500-1,000	3	59	19	58	3	20	77	22
200-499	3	30	13	67	10	10	80	23
<200	4	17	18	65	6	12	83	24

Table XV (A): Laceration case treatment by ambulance company

N=533

Company	N	%A	%B	%C	%D	%A+B	%A+C
C_1	73	32	38	16	12	70	48
C_2	36	61	19	11	8	80	72
C_3	126	57	29	4	10	86	61
C_4	146	48	34	9	10	82	57
C_5	41	63	32	5	0	95	68
C_6	41	56	32	7	5	88	63
C_7	1	0	100	0	0	100	0
C_8	1	100	0	0	0	100	100
C_{10}	1	0	0	0	100	0	0
C_{11}	2	100	0	0	0	100	100
V_1	7	57	29	0	14	86	57
V_2	13	38	38	8	15	76	46
V_6	10	80	10	0	10	90	80
V_7	1	100	0	0	0	100	100
V_{10}	23	43	30	9	17	73	52
Other	11	55	9	18	18	64	73
All C	468	51	32	8	9	83	59
All V	65	52	25	8	14	77	60

Table XV (B): Laceration case treatment by company total case volume

Cases/4 mo	#Co's	Total Lac. cases	%A	%B	%C	%D	%A+B	%A+C
500-1,000	3	345	48.1	33.0	8.7	10.1	81.1	56.8
200-499	3	118	60.2	28.0	7.6	4.2	88.2	67.8
100-199	1	23	43.0	30.0	9.0	17.0	73.0	52.0
50-99	2	17	70.6	17.6	0	11.8	88.2	70.6
<50	4	17	47.1	35.3	5.9	11.8	82.4	53.0

Table XVI (A): Fractured hip case treatment by ambulance company

Company	N	%A	%B	%C	%D	%A+B	%A+C
C_1	5	0	80	0	20	80	0
C_2	3	67	0	0	33	67	67
C_3	7	57	0	29	14	57	76
C_4	20	30	30	15	25	60	45
C_5	2	50	0	50	0	50	100
C_6	5	0	100	0	0	100	0
C_9	1	0	100	0	0	100	0
V_1	1	0	100	0	0	100	0
V_3	1	0	100	0	0	100	0
V_5	1	0	100	0	0	100	0
V_{10}	3	33	67	0	0	100	37
All C's	43	30	37	14	19	67	44
All V's	6	17	83	0	0	100	17

Table XVI (B): Fractured hip case treatment by company total case volume

Cases/4 mo.	#Co's	Tot. Cases	%A	%B	%C	%D	%A+B	%A+C
500-1,000	3	32	31	31	15	22	62	46
200-499	3	10	30	50	10	10	80	40
<200	5	7	14	86	0	0	100	14

Table XVII (A): EMT's trained as of June, 1975

N=462; 11 classes

Type of Organization	Comm	221	50%
	Mun	105	24%
	Vol	113	26%
Previous Training	CPR	211	47%
	R.C.	228	51%
	A.R.C.	285	64%
	NATI	72	15%
	91A&91B Arm. Forces	30	6%
Sex	Male	439	95%
	Female	23	5%
Education	<12 yrs	36	8%
	12 yrs	252	57%
	13-15	127	29%
	16+	32	7%
Age	≤20	31	6.7
	21-25	117	25.4
	26-30	103	22.3
	31-35	101	21.9
	36-40	54	11.7
	41-45	30	6.4
	46+46	26	5.6

Table XVII (B): EMT total case experience

	Drivers			*Attendants*				
Total cases Carried	*N*	*% of all surveyed EMT's*	*% of drivers (185)*	*N*	*% of all surveyed EMT's*	*% of attendants (203)*	*Total as attendants or drivers*	*%*
0	67	26.6	0	49	19.4	0	0	0
≤10	115	45.6	62.2	124	49.2	61.1	141	56.0
11-50	46	18.2	24.9	55	21.8	27.1	49	19.4
51-100	13	5.2	7.0	15	6.0	7.4	38	15.1
101-100	10	4.0	5.4	9	3.6	4.4	17	6.7
201-300	1	0.4	0.5	0	0	0	7	2.8
	252	100%	100%	252	100%	100%	252	100%

Table XVIII: Comparison of EMT performance by total case volume

EMT total case volume in survey (as attendant)	#EMT's	#MI Cases	#A	#B	#C	#D	%A+C
A. DX: Myocardial infarction							
>100	9	84	31	11	23	19	54
			(36.9)	(13.1)	(27.4)	(22.6)	(64.3)
<10	29	62	24	10	14	13	38
			(38.7)	(16.1)	(22.6)	(21.0)	(61.3)
B. DX: Fractured tibia/fibula							
>100	9	27	6	5	5	11	11
			(22.2)	(18.5)	(18.5)	(40.7)	(40.7)
<10	12	14	2	4	4	4	6
			(14.3)	(28.6)	(28.6)	(28.6)	(42.9)
C. DX: Stroke							
>100	9	30	11	12	2	5	13
			(36.7)	(40.0)	(6.7)	(16.7)	(43.3)
<10	27	50	8	32	1	9	9
			(16.0)	(64.0)	(2.0)	(18.0)	(18.0)
D.DX: Pulm. edema							
>100	3	13	3	1	7	2	10
			(23.1)	(7.7)	(53.8)	(15.4)	(76.9)
<10	9	10	1	2	6	1	7
			(10)	(20)	(60)	(10)	(70)
E. DX: Fractured hip							
>100	6	13	3	9	0	1	3
			(23.1)	(69.2)		(27)	(23.1)
<10	11	18	5	6	3	4	8
			(27.8)	(33.3)	(16.7)	(22.2)	(44.4)

Table XIX: EMT diagnostic/treatment matrix values for each of 10 diagnostic conditions by socioeconomic quintile

(A). Dx: Myocardial infarction

Pt. SES	N	A	B	C	D	Total % A+C
1	37	11	7	10	9	56.7%
	(20.4)	29.7	18.9	27.0	24.3	
2	43	13	8	11	11	
	(23.8)	30.2	18.6	25.6	25.6	55.8%
3	38	12	7	10	9	
	(21.0)	31.6	18.4	26.3	23.7	57.9%
4	39	13	7	10	9	
	(21.5)	33.3	17.9	25.6	23.1	58.9%
5	24	8	5	6	5	
	(13.3)	33.3	20.8	25.0	20.8	58.3%
Totals	181	57	34	47	43	
	(100%)	(31.5)	(18.8)	(26.0)	(23.8)	57.5%

(B). Dx: Pulmonary edema

Pt. SES	N	A	B	C	D	Total % A+C
1	3	1	0	1	1	
	(12.5)	33.3	0	33.3	33.3	66.6%
2	5	1	1	2	1	
	(20.8)	20.0	20.0	40.0	20.0	60.0%
3	6	2	1	3	0	
	(25.0)	33.3	16.7	50.0	0	83.3%
4	5	1	1	3	0	
	(20.8)	20	20	60	0	80%
5	5	2	0	2	1	
	(20.8)	40	0	40	20	80%
Totals	24	7	3	11	3	
	(100%)	(29.2)	(12.5)	(45.8)	(12.5)	75^{0}%

Table XIX: EMT diagnostic/treatment matrix values for each of 10 diagnostic conditions by socioeconomic quintile (continued)

(C). Dx: Emphysema

Pt. SES	N	A	B	C	D	Total % A+C
1	7	2	1	2	2	
	(17.1)	28.6	14.3	28.6	28.6	57.2%
2	8	2	1	2	3	
	(19.5)	25	12.5	25	37.5	50%
3	12	3	2	3	4	
	(29.3)	25	16.7	25	33.3	50%
4	8	2	1	3	2	
	(19.5)	25	12.5	37.5	25	57.5%
5	6	1	1	2	2	
	(14.6)	16.7	16.7	33.3	33.3	50.0%
Totals	41	10	6	12	13	
	(100%)	(24.4)	(14.6)	(29.3)	(31.7)	53.7%

(E). Dx: Stroke

Pt. SES	M	A	B	C	D	Total % A+C
1	14	2	8	1	3	
	(13.2)	14.3	57.1	7.1	21.4	21.4%
2	14	2	9	1	2	
	(13.2)	14.3	64.3	7.1	14.3	21.4%
3	29	6	17	2	4	
	(27.4)	20.7	58.6	6.9	13.8	27.6%
4	21	4	13	1	3	
	(19.8)	19.0	61.9	4.7	14.3	23.7%
5	28	4	18	1	5	
	(26.4)	14.3	64.3	3.6	17.9	17.9%
Totals	106	18	65	6	17	
	(100%)	(17.0%)	(61.3%)	(5.7%)	(16.0%)	22.7%

(D). Dx: Arrhythmia

Pt. SES	N	A	B	C	D	Total % A+C
1	10	7	1	1	1	
	(13.0)	70	10	10	10	80%
2	16	10	2	1	3	
	(20.8)	62.5	12.5	6.2	18.7	68.7%
3	19	13	2	2	2	
	(24.7)	68.4	10.5	10.5	10.5	78.9%
4	13	10	1	1	1	
	(16.9)	76.9	7.7	7.7	7.7	84.6%
5	19	15	0	2	2	
	(24.7)	79.0	0	10.5	10.5	89.5%
Totals	77	55	6	7	9	
	(100%)	(71.4%)	(7.8%)	(9.1%)	(11.7%)	83.1%

(F). Dx: Fractured Ankle

Pt. SES	N	A	B	C	D	Total % A+C
1	1	0	0	1	0	
	(5.0)	0	0	100	0	100%
2	3	2	0	1	0	
	(15.0)	66.7	0	33.3	0	100%
3	3	2	0	1	0	
	(15.0)	66.7	0	33.3	0	100%
4	5	3	0	2	0	
	(25.0)	60	0	40	0	100%
5	8	4	0	4	0	
	(40.0)	50	0	50	0	100%
Totals	20	11	0	9	0	
	(100%)	(55%)		(45%)		100%

Table XIX: EMT diagnostic/treatment matrix values for each of 10 diagnostic conditions by socioeconomic quintile (continued)

(G). Dx: Fractured tibia/fibula

Pt. SES	N	A	B	C	D	Total % A+C
1	4	0	1	1	2	
	(10.3)	0	25	25	50	25%
2	5	2	2	0	1	
	(12.8)	40	40		20	40%
3	6	1	3	1	1	
	(15.4)	16.7	50	16.7	16.7	33.4%
4	8	1	1	2	4	
	(20.5)	12.5	12.5	25	50	37.5%
5	16	3	4	4	5	
	(41.0)	18.8	25	25	31.2	43.8%
Totals	39	7	11	8	13	
	(100%)	(17.9%)	(28.2%)	(20.5%)	(33.3%)	38.4%

(H). Dx: Laceration

Pt. SES	N	A	B	C	D	Total % A+C
1	50	24	17	4	5	
	(9.4)	48	34	8	10	56%
2	64	32	19	6	7	
	(12.0)	50	29.7	9.4	10.9	59.4%
3	85	42	28	6	9	
	(15.9)	49.4	32.9	7.1	10.6	56.5%
4	101	55	29	9	8	
	(18.9)	54.5	28.7	8.9	7.9	63.4%
5	233	122	70	20	21	
	(43.7)	52.4	30.0	8.6	9.0	61.0%
Totals	533	275	163	45	50	
	(100%)	(51.6%)	(30.6%)	(8.4%)	(9.4%)	60.0%

(I). Dx: Fractured Femur

Pt. SES	N	A	B	C	D	Total % A+C
1	1	0	0	1	0	
	(4.5)			100		100%
2	3	1	0	0	2	
	(13.6)	33.3			66.7	33.3%
3	4	1	1	2	0	
	(18.2)	25	25	50		75%
4	4	1	0	2	1	
	(18.2)	25		50	25	75%
5	10	3	0	5	2	
	(45.5)	30	0	50	20	80%
Totals	22	6	1	10	5	
	(100%)	(27.3%)	(4.5%)	(45.4%)	(22.7%)	72.7%

(J). Dx: Fractured hip

Pt. SES	N	A	B	C	D	Total % A+C
1	5	1	2	1	1	
	(10.2)	20	40	20	20	40%
2	7	2	3	0	2	
	(14.3)	28.6	42.9		28.6	28.6%
3	7	2	3	1	1	
	(14.3)	28.6	42.9	14.3	14.3	42.9%
4	10	3	4	2	1	
	(20.4)	30	40	20	10	50%
5	20	6	9	2	3	
	(40.8)	30	45	10	15	40%
Totals	49	14	21	6	8	
	(100%)	(28.6%)	(42.9%)	(12.2%)	(16.3%)	40 8%

Table XX: EMT diagnostic/treatment matrix values for aggregate of 10 diagnostic conditions by socioeconomic quintile

Pt. SES	N	A	B	C	D	Total % A+C
1	132	48	37	23	24	
	12.1%	36.4	28.0	17.4	18.2	53.8%
2	168	67	45	24	32	
	15.4%	39.9	26.8	14.3	19.0	54.2%
3	209	84	64	31	30	
	19.1%	40.2	30.6	14.8	14.4	55.0%
4	214	93	57	35	29	
	19.6%	43.5	26.6	16.4	13.6	59.9%
5	369	168	107	48	46	
	33.8%	45.5	29.0	13.0	12.5	58.5%
Totals	1092	460	310	161	161	
(100%)	(42.1%)	(28.4%)	(14.7%)	(14.7%)	56.8%	

TRANSPORTATION POSITION	TRANSPORTATION EQUIPMENT
☐ Prone	☐ Flat
☐ Supine	☐ Contour
☐ Sit	☐ Scoop
☐ Shock	☐ Cardiac Chair
☐ Head Up	☐ Sit
☐ Side	☐ Walk

TREATMENT

AIRWAY

☐ Oropharyngeal
☐ Head Tilt
☐ Jaw Pull
☐ Bite Block

☐ Suction
☐ Manual Clear

☐ CPR

ASSISTED VENT

☐ Mouth to Mouth
☐ Bag Mask w/O_2
☐ Bag Mask No O_2
☐ Mech. Resus -Manual
☐ Mech. Resus -Autocycle

SPONTANEOUS VENT & O_2

☐ Mask
☐ Cannula

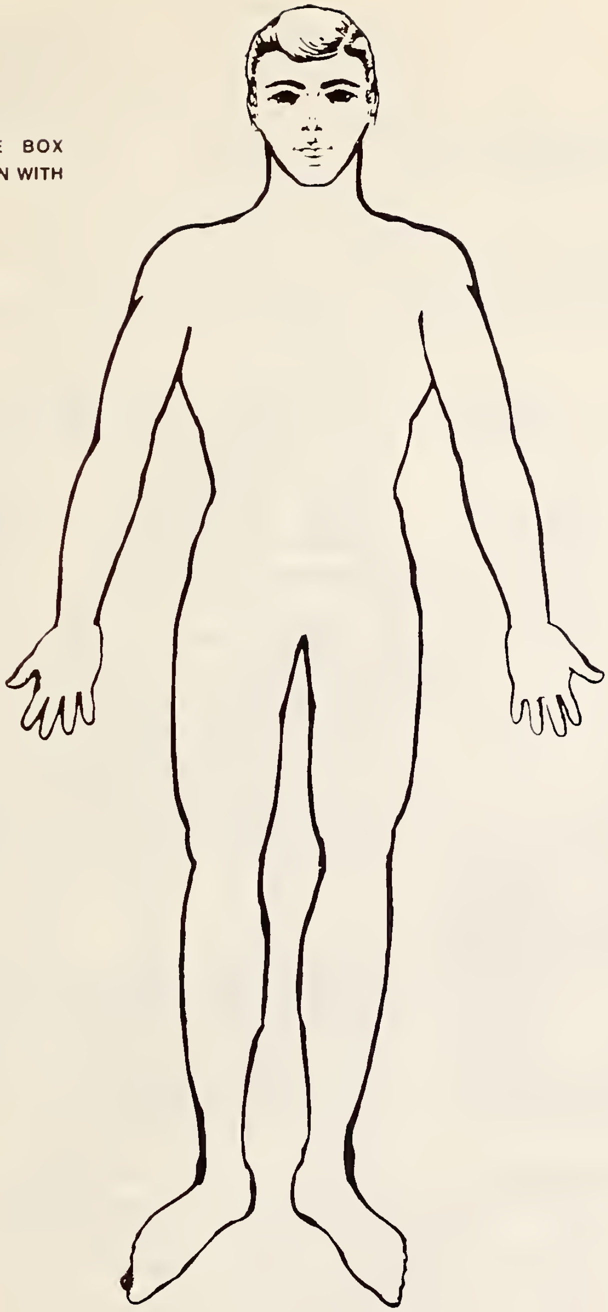
CHECK APPROPRIATE BOX AND INDICATE LOCATION WITH LINE AND SHADING

SPLINTS

☐ Extr Strgn'd
☐ Extr Elv'd
☐ S Backboard
☐ L Backboard
☐ Cervical
☐ Ankle Air
☐ Leg Air Sht.
☐ Leg Air Lng.
☐ Arm Air
☐ Thomas
☐ Board Extrem.
☐ Pillow
☐ Sling
☐ Swathe
☐ Traction
☐ Sand Bags
☐ Dressed
☐ Other Rx

MISC.

☐ Restraints
☐ Irrigation
☐ Ice Packs
☐ Tourniquet
☐ Bag Rebreathe
☐ OB Kit
☐ Reassurance
☐ Other



CHECK APPROPRIATE BOX AND INDICATE LOCATION WITH LINE

DRESSINGS

☐ Pressure
☐ Occlusive
☐ Protective
☐ Immobilize
☐ 4x4's
☐ Kling
☐ Kerlix
☐ ABD/Trauma
☐ Battle
☐ Triangular
☐ Ace
☐ Muslin/Bandage
☐ Other

BURNS

Indicate with shading all visible burned areas.

PATIENT CONDITION

☐ Labored Respiration
☐ Cyanotic
☐ Seizure
☐ Pale Skin
☐ Vomiting
☐ Anxious/Agitated
☐ Combative
☐ Unconscious
☐ Severe Bleeding

AMBULANCE CO.	ENCOUNTER FORM # 05268

REMARKS.

ID

PATIENT NAME | TELEPHONE NO | DATE MO DAY YR | DISPATCH NUMBER

ADDRESS | SEX ☐M ☐F | RACE - ☐ W ☐ B ☐ SS ☐ O | DATE OF BIRTH MO DAY YR

BILLING INFO

RESPONSIBLE PARTY | RELATIONSHIP | OFFICE USE ONLY

ADDRESS | TELEPHONE NO

EMPLOYER | ☐ WORKMANS COMP | OCCUPATION

STATE WELFARE # ☐ | MEDICARE # ☐ | CITY WELFARE # ☐ | ☐ OTHER INSURANCE

☐ BASE | ☐ O2 | ☐ DISP MASK | ☐ NITE | ☐ FEMALE ATTEND | ☐ RESUS. | ☐ SUCTION MACHINE | ☐ CANCELLED CALL | MILEAGE ☐ MI | WAITING TIME ☐ HRS | OTHER ☐

	TIME (2400 HRS)
DISPATCH	
ARRIVE SCENE	
DEPART SCENE	
ARRIVE HOSP.	

SITUATION & COMPLAINT

PICK-UP LOCATION | FROM | DESTINATION

☐ Street ☐ Highway ☐ Interstate ☐ Home ☐ Business/Industry ☐ Hospital ☐ Institution ☐ Dr. Office ☐ Recreation ☐ School

OTHER ASSISTANCE | WHAT ASSISTANCE

☐ Fire Dept. ☐ Fire Rescue ☐ Police Local ☐ Police State ☐ Bystander ☐ Nurse ☐ MD ☐ Hospital ☐ Other

CHIEF COMPLAINT | AT DISPATCH | AT SCENE

HISTORY/REMARKS THIS ACCIDENT/ILLNESS

☐ ETOH

TRAUMA ☐ YES ☐ NO | ☐ VEHICULAR | ☐ NON-VEHICULAR

TIME
Onset of Illness/Injury
☐ Sudden ___ min
☐ Recent ___ hrs
☐ Long Term ___ days

HISTORY
☐ Heart Cond.
☐ Emphy or Lung Dis.
☐ Cancer
☐ CVA/Stroke
☐ Diabetes
☐ Seizure

Pt. was:	In
☐ Driver	☐ Car
☐ Front Pass.	☐ Truck/Bus
☐ Rear Pass. R	☐ Motorcycle
☐ Rear Pass. L	☐ Bicycle
☐ Pedestrian	☐ Snowmobile

# of vehicles involved ☐ 1 ☐ 2 ☐ 3 ☐ 4 OR MORE

IMPACT SITE	INVOLVED WITH
☐ Front	☐ Car
☐ Rear	☐ Truck
☐ L. Side	☐ Bicycle
☐ R. Side	☐ Motorcycle
☐ Top	☐ **Seatbelts Used**

# of people injured ☐ 1 ☐ 2 ☐ 3 ☐ 4 OR MORE

☐ Fall 0-5
☐ Fall 5-20
☐ Fall 20 +
☐ Machinery
☐ Self-Inflicted
☐ 2nd. Party Inflic.
Agent___

☐ Ingestion of Toxin
☐ OD
☐ Burns/Flame
☐ Hot Substance
☐ Other Burns
☐ Contact Sports
☐ Other Trauma
TYPE___

PATIENT CONDITION

OBSERVATIONS	AT SC	ON ROUTE IMP	ON ROUTE WORSE
CARD ARREST	☐	☐	☐
RESP. DISTRESS	☐	☐	☐
RESP. ARREST	☐	☐	☐
SHOCK	☐	☐	☐
CYANOSIS	☐	☐	☐
AIRWAY OBSTRUCT	☐	☐	☐
SEIZURE	☐	☐	☐
IRREG. PULSE	☐	☐	☐
WEAK PULSE	☐	☐	☐
PUPILS ☐ UN - ☐ FIXED ☐ PIN POINT ☐ DILATED	☐	☐	☐
PALE SKIN	☐	☐	☐
VOMITING	☐	☐	☐
PERSPIRATION	☐	☐	☐
ANXIOUS/AGITATED	☐	☐	☐
COMBATIVE	☐	☐	☐

LOCATION		INJURY BONE/JOINT	INJURY SOFT TIS.	PAIN LOC.	ABSENT SENSATION
HEAD		☐	☐	☐	☐
FACE		☐	☐	☐	☐
NECK		☐	☐	☐	☐
CHEST		☐	☐	☐	☐
BACK		☐	☐	☐	☐
ABD/PELVIS		☐	☐	☐	☐
SHOULDER	L R B	☐	☐	☐	☐
ARM	L R B	☐	☐	☐	☐
ELBOW	L R B	☐	☐	☐	☐
FOREARM	L R B	☐	☐	☐	☐
HAND/WRIST	L R B	☐	☐	☐	☐
HIP	L R B	☐	☐	☐	☐
THIGH	L R B	☐	☐	☐	☐
KNEE	L R B	☐	☐	☐	☐
LEG	L R B	☐	☐	☐	☐
FOOT/ANKLE	L R B	☐	☐	☐	☐

SIGNS & SYMPTOMS

APPEARANCE	GOOD ☐	FAIR ☐	POOR ☐	CRITICAL ☐
CONSCIOUSNESS	NORM ☐	DAZED CONFUSED ☐	SEMICONS ☐	UNCONSC ☐
ORIENTATION	ORIENTED ☐	PLACE/TIME ☐	PERSON ☐	DISORIENT'D ☐
BREATHING	NORM ☐	RAPID ☐	LABORED ☐	ABSENT ☐
BLEEDING	NONE ☐	MIN ☐	MODERATE ☐	SEVERE ☐
PAIN	NONE ☐	MIN ☐	MODERATE ☐	SEVERE ☐
PULSE	NORM ☐	SLOW ☐	RAPID ☐	ABSENT ☐

PULSE RATE 1 | 2 | RESP RATE 1 | 2

BLOOD PRESSURE 1 / | 2 /

EMT CLINICAL IMPRESSION 1 | 2 | 3 | 4

TREATMENT

HEART LUNG AIRWAY

AIRWAY
☐ Oropharyngeal
☐ Head Till
☐ Jaw Pull
☐ Bite Block
☐ SUCTION
☐ Manual Clear
☐ CPR

ASSISTED VENT
☐ Mouth To Mouth
☐ Bag Mask with O2
☐ Bag Mask no O2
☐ Mech Resus. Manual
☐ Mech Resus. Autocycle
SPONTANEOUS VENT
☐ Mask
☐ Cannula O2

TRANSPORT POSITION
☐ Prone
☐ Supine
☐ Shock
☐ Head Up
☐ Side
☐ Sit
☐ Comfort

LIFT/MOVE EQUIPMENT
☐ Flat
☐ Contour
☐ Scoop
☐ Cardiac Chair
☐ Stokes/Basket
☐ Sit/Walk

SPLINTS
☐ S. Backboard
☐ L. Backboard
☐ Cervical Col
☐ Sand Bag
☐ Extr. Strgn'd
☐ Extr Elv'd
☐ Sling
☐ Swathe
☐ Board Extrem
☐ Arm Air
☐ Thomas
☐ Leg Air Sht.
☐ Leg Air Lng
☐ Ankle Air
☐ Pillow
☐ Traction
☐ Dressed
☐ Other Rx (SEE REMARKS)

DRESSINGS
☐ Pressure
☐ Occlusive
☐ Protective
☐ Immobilize
☐ 4 x 4's
☐ Kling
☐ Kerlix
☐ Wet Dress
☐ Burn Sheet
☐ ABD/Trauma
☐ Battle
☐ Triangular
☐ Ace
☐ Muslin/Bandage
☐ Other

MISC.
☐ Restraints
☐ Irrigation
☐ Ice Packs
☐ Tourniquet
☐ Pt. Own Med.
☐ Bag Rebreathe
☐ OB Kit
☐ Reassurance
☐ Other (SEE REMARKS)

RESCUE ☐ LIGHT ☐ MEDIUM ☐ HEAVY

RUN INFO

EMERGENCY VEHICLE NO | EMT 1 DRIVER | EMT 2 ATTENDANT | EMT 3 ATTENDANT | OTHER | PHYSICIAN

NATURE OF RUN (TO FM)
☐ ☐ Priority 1
☐ ☐ Priority 2
☐ ☐ Priority 3
☐ ☐ Standby
☐ Dry Run
☐ No Care Required
☐ Cancelled-Req. But Refused
☐ Trans. Other Means

RUN CONDITIONS (TO FM)
☐ ☐ Lights
☐ ☐ Siren
☐ ☐ Severe Traffic
☐ ☐ Adverse Weather
☐ ☐ Mechanical Trouble
☐ ☐ Communication Trouble
☐ ☐ Ambulance Accident
☐ ☐ Trbl. Locating
☐ ☐ Other

REMARKS

PATIENTS SIGNATURE | DATE

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Current NCHSR Publications

National Center for Health Services Research publications of interest to the health community are available on request to NCHSR, Office of Scientific and Technical Information, 3700 East-West Highway, Room 7-44, Hyattsville, MD 20782 (telephone: 301/436-8970). Mail requests will be facilitated by enclosure of a self-addressed, self-adhesive mailing label. These publications also are available for sale through the National Technical Information Service (NTIS), Springfield, VA 22161 (telephone: 703/557-4650). PB and HRP numbers in parentheses are NTIS order numbers. Publications which are out of stock in NCHSR are indicated as available only from NTIS. Prices may be obtained from the NTIS order desk on request.

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(HRA) 77-3158	Summary of Grants and Contracts, Active June 30, 1976
(HRA) 77-3167	Emergency Medical Services Systems Research Projects (Active as of June 30, 1976) (PB 264 407, available NTIS only)
(HRA) 77-3179	Research on the Priority Issues of the National Center for Health Services Research, Grants and Contracts Active on June 30, 1976
(HRA) 77-3194	Emergency Medical Services Systems Research Projects, 1977 (PB 273 893)
(HRA) 78-3202	NCHSR Research Bibliography (July 1, 1976 to June 30, 1977) (PB 273 997)

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(HRA) 76-3150	Intermountain Medical Malpractice (PB 268 344, available NTIS only)
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(HRA) 77-3186	International Conference on Drug and Pharmaceutical Services Reimbursement (PB 271 386)
(PHS) 78-3195	Emergency Medical Services: Research Methodology (PB 279 096)

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16. Abstracts
An evaluation was conducted of the diagnostic accuracy and treatment appropriateness of emergency medical technicians (EMTs) in caring for 4,455 consecutive patients during a four and one-half month period. Data on EMT diagnosis and treatment and physician diagnosis were collected, and EMT data validated by observers. There were 58 diagnostic conditions for which treatments were mandated as determined by a physician panel, affecting 2,233 (50 percent) patients. EMT diagnostic accuracy was measured using physician diagnosis as the standard, and rates of appropriate treatment were based upon the list of mandated treatments. Diagnostic accuracy tended to be mediocre, but treatment appropriateness varied by diagnosis and severity. Serious medical and trauma conditions received appropriate treatment far more frequently than non-serious conditions. Essential changes in educational approach and emphasis are discussed.

~~17. Key Words and Document Analysis. 17a. Descriptors~~

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